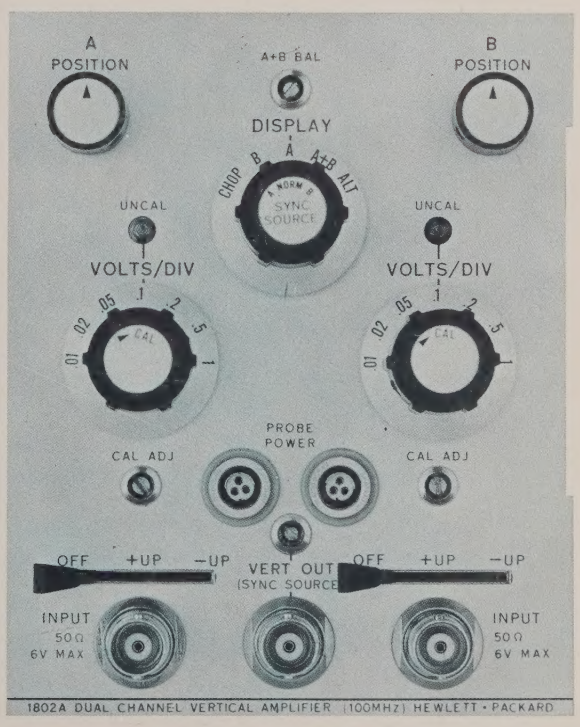
OPERATING AND SERVICE MANUAL

DUAL CHANNEL VERTICAL AMPLIFIER

1802A



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The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

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OPERATING AND SERVICE MANUAL

MODEL 1802A
DUAL CHANNEL VERTICAL AMPLIFIER

SERIALS PREFIXED: 827-

See Section I For Instruments With Other Serial Prefixes.

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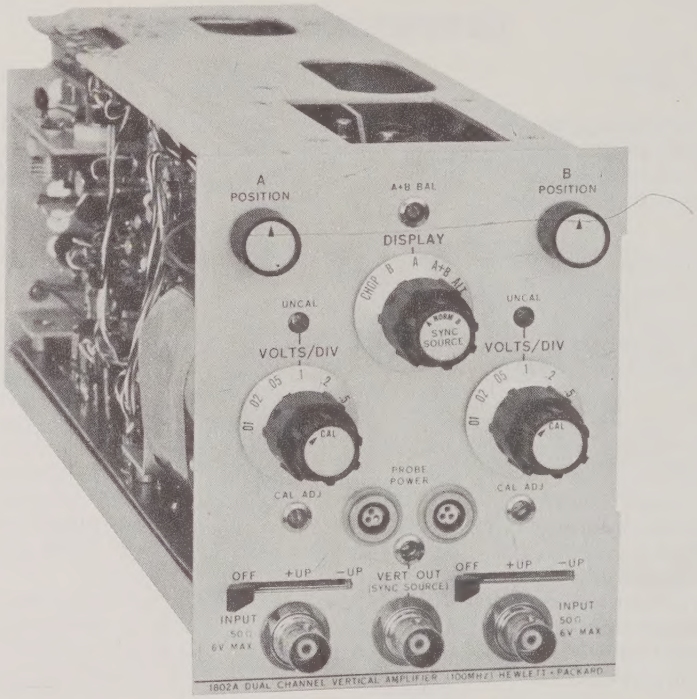


Figure 1-1. Model 1802A Dual Channel Vertical Amplifier

Table 1-1. Specifications

MODES OF OPERATION

Channel A alone; Channel B alone; Channels A and B displayed alternately on successive sweeps (ALT); Channels A and B displayed by switching at approx. 400 kHz rate between channels (CHOP), with blanking during switching; Channel A plus Channel B (algebraic addition). Vertical output allows cascading of channels.

EACH CHANNEL

BANDWIDTH

DIRECT: DC to greater than 100 MHz (3 dB down from 8 div reference signal); with channels cascaded, dc to greater than 75 MHz.

WITH MODEL 1123A ACTIVE PROBE: Same as Direct for source resistances from 0 to 150 ohms.

WITH MODEL 10020A RESISTIVE DIVIDER PROBES: Same as Direct for source resistances from 0 to 750 ohms.

WITH MODEL 10201A-D RESISTIVE DIVIDER PROBES: Same as Direct for source resistances from 0 to 1000 ohms.

RISETIME

DIRECT: Less than 3.5 ns (10% to 90% with 6 div input step); with channels cascaded, less than 4.5 ns.

WITH MODEL 1123A ACTIVE PROBE: Same as Direct for source resistances from 0 to 150 ohms.

WITH MODEL 10020A RESISTIVE DIVIDER PROBES: Same as Direct for source resistances from 0 to 750 ohms.

WITH MODELS 10201A-D RESISTIVE DIVIDER PROBES: Same as Direct for source resistances from 0 to 1000 ohms.

PULSE RESPONSE

(6 div reference at 25° C) overshoot,<3% perturbations,<3%; tilt, <2%. With channels cascaded: overshoot,<5%; perturbations,<5%; tilt,<3%.

DEFLECTION FACTOR

RANGES: From 0.01 V/div to 1 V/div (7 positions) in a 1, 2, 5 sequence. ±3% accuracy with Vernier in calibrated position; calibration adjustment provided on front panel. Channels may be cascaded using vertical output to obtain 1, 2, or 5 mV/div.

VERNIER: With UNCAL (uncalibrated) light, continuously variable between all ranges; extends maximum deflection factor to at least 2.5 V/div.

POLARITY

+UP or -UP, selectable; OFF position disconnects signal input from amplifier, terminates input

SECTION I
GENERAL INFORMATION

1-1. GENERAL DESCRIPTION.

1-2. The Model 1802A is a dual channel vertical amplifier (see Figure 1-1) designed to operate as an integral part of the HP Model 180-Series Oscilloscopes. Its unique design features fixed input impedance (50 ohms), wide band pass (dc to 100 MHz), and a higher sensitivity when operated in cascade than most standard vertical plug-ins (see detailed theory in Section IV). Refer to Table 1-1 for instrument specifications.

1-3. During operation, the Model 1802A can be direct-coupled (by 50-ohm coax) to examine signals originating from 50-ohm sources, or with the use of an active probe (e.g., the Model 1123A) it can be used to examine high frequency signals within an operating circuit. For low level signals, the vertical and sync amplifiers can be operated in cascade to produce a higher gain, thereby increasing overall instrument sensitivity; and, in this configuration, bandwidth is 75 MHz. The DISPLAY control permits the selection

Table 1-1. Specifications (Cont'd)

signal in 50 ohms, and grounds amplifier input for reference.

SIGNAL DELAY

Input signals are delayed sufficiently to view leading edge of input pulse without advance external trigger.

DYNAMIC RANGE

6 divisions for signals to 100 MHz, increasing to 8 div at 50 MHz.

POSITIONING RANGE

Allows positioning top of a 6 div pulse to center graticule line.

DRIFT

Less than ±1 div over environmental temperature range (except for cascaded operation).

INPUT IMPEDANCE

50 ohms ±2 ohms.

MAXIMUM INPUT

6V rms.

VSWR

Less than 1.35:1 at 100 MHz on 0.01 V/div; less than 1.1:1 at 100 MHz on all other deflection factors.

REFLECTION COEFFICIENT

Less than 15% at 100 MHz on 0.01 V/div; less than 5% at 100 MHz on all other deflection factors.

PROBE POWER

Provides power to operate Model 1123A Active Probe.

A + B OPERATION

AMPLIFIER

Bandwidth and deflection factor are unchanged; either channel may be inverted to give ±A±B operation.

DIFFERENTIAL INPUT (A-B)

Common mode rejection ratio greater than 40 dB for frequencies to 1 MHz, greater than 20 dB to 100 MHz; common mode signal, up to amplitude equivalent of 6 div deflection.

TRIGGERING

MODE

Normal, on the signal displayed as selected by DISPLAY switch; A, on Channel A signal; B, on Channel B signal.

FREQUENCY

DC to greater than 120 MHz on 1 div pk-pk signal for Models 1820B or 1822A time base plug-ins; or from DC to greater than 75 MHz on 1 div pk-pk signal for Models 1820A or 1821A time base plug-ins.

VERTICAL SIGNAL OUTPUT

AMPLITUDE

100 mV/div of displayed signal into 50-ohm load, adjustable with front panel control; usable amplitude, 600 mV pk-pk.

BANDWIDTH

DC to greater than 100 MHz.

RISETIME

Less than 3.5 ns.

GENERAL

WEIGHT

Net, 4 1/2 pounds (2,0 kg); shipping, 7 pounds (3,2 kg).

ENVIRONMENT

Same as Model 180A/AR except temperature which is 0° C to +55° C.

ACTIVE COMPONENTS

All solid-state.

ACCESSORIES FURNISHED

Calibrator adapter (HP Part No., 01802-63201).

of CHOP, B, A, A + B, and ALT, which increases the versatility of the system.

1-4. INSTRUMENT IDENTIFICATION.

1-5. Hewlett-Packard uses an eight-digit serial number (000-00000) for unit identification. The first three digits are referred to as the "serial prefix" and separated from the rest of the digits by a hyphen. Succeeding digits identify a particular instrument within the series. The instrument serial number is located on a plate riveted to the rear panel.

1-6. MANUAL CHANGES.

1-7. A "serial prefix" number is printed on the title page to associate this manual with a specific series of instruments. Since it is readily known what instrument is covered by the manual, it is relatively easy to provide backdating for earlier instruments and updating by the use of "Manual Change" sheets for later instruments. Refer to Section VII for backdating information. All updating information is incorporated as insert sheets entitled "Manual Changes". All questions concerning the instrument or manual should be directed to your nearest Hewlett-Packard Sales/Service Office. Be sure to include the instrument model and complete HP serial number in all correspondence.

1-8. ACCESSORY PROBE.

1-9. The Model 1123A Voltage Probe was designed for use with the Model 1802A to ensure maximum versatility. Probe input impedance is 100k ohms paralleled by 3.5 picofarads of capacitance. Output impedance is 50 ohms which furnishes a matched source for the 50-ohm input of the Model 1802A.

1-10. SCOPE OF MANUAL.

1-11. This section contains general information about the Model 1802A instrument and manual. Each subsequent section provides detailed facts concerning the particular area being dealt with; e.g., Section III furnishes detailed operation instructions for specific measurement functions. To ensure a thorough understanding of the Model 1802A, its operation is discussed at four different levels of complexity: (1) General Description (in this section), (2) Functional Description (in Section IV), (3) Detailed Theory of Operation (in Section IV), and (4) Simplified Circuit Theory (preceeding both the Functional Description and the Detailed Theory of Operation) also in Section IV.

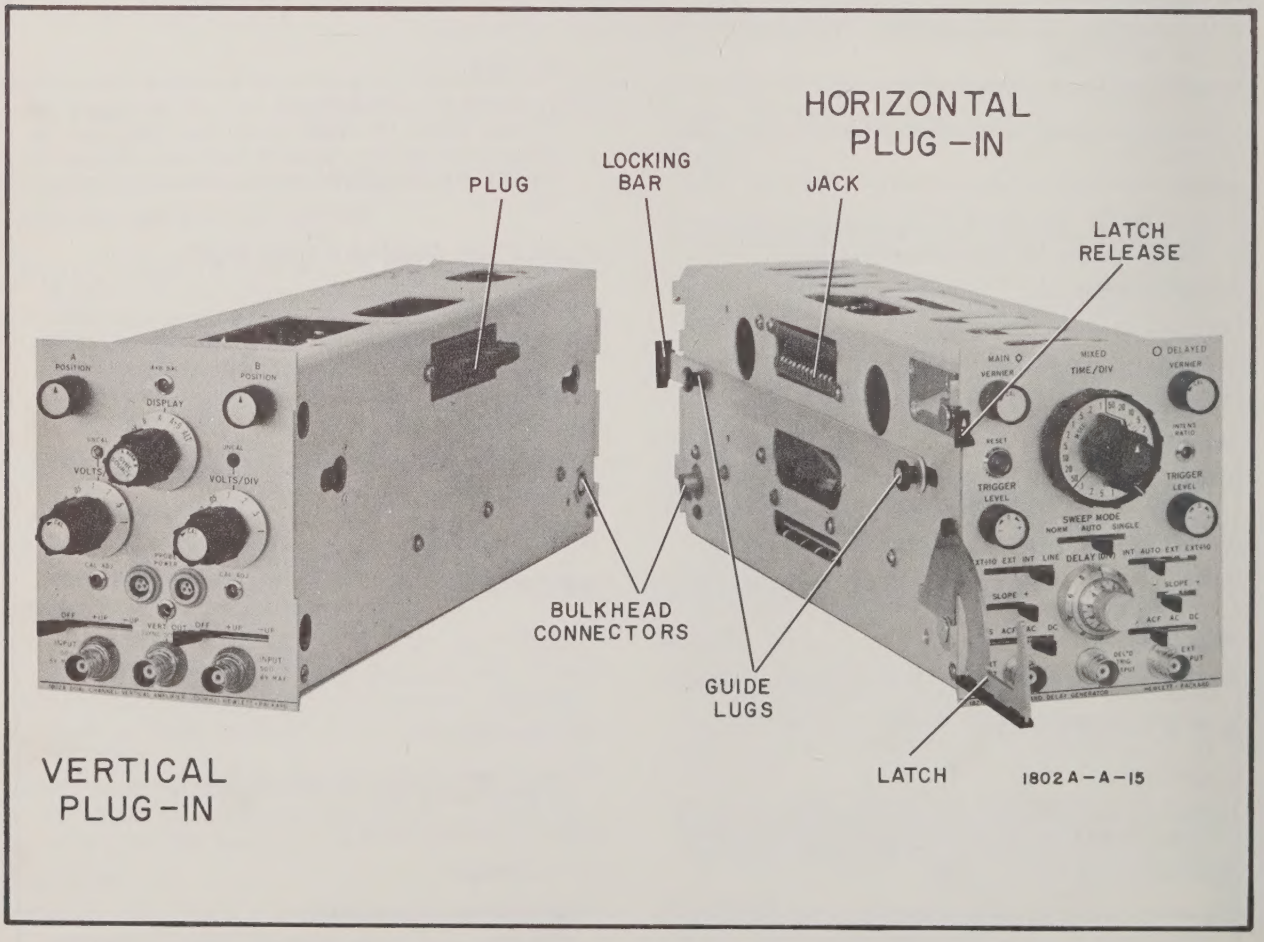


Figure 2-1. Plug-In Mating

SECTION II
INSTALLATION

2-1. GENERAL.

2-2. This section contains preliminary inspection and installation procedures for the Model 1802A Dual Channel Vertical Amplifier. In addition, unpacking and claims procedures are discussed in the event damage to the instrument occurs during transit.

2-3. INITIAL INSPECTION.

2-4. MECHANICAL CHECK. Check the shipping carton for damage immediately after receipt. If it is damaged, ask the carrier's agent to be present when the instrument is unpacked. Inspect the Model 1802A for physical damage such as bent or broken parts and dents or scratches. If damage is found, refer to Paragraph 2-6 for recommended claim procedure. If the instrument appears undamaged, perform the electrical check. Retain the packaging material for possible future use.

2-5. ELECTRICAL CHECK. The performance check is given in Section V. This check will determine whether or not the instrument is operating within specifications listed in Table 1-1. The initial performance and accuracy of this instrument are certified as stated in the warranty on the inside front cover of this manual. If the instrument does not perform as specified, refer to Paragraph 2-6 for the recommended claim procedure.

2-6. CLAIMS.

2-7. If physical damage is found or if the instrument is not within the specifications when received, notify the carrier and the nearest HP Sales/Service Office immediately. The Sales/Service Office will arrange for repair or replacement without waiting for a claim to be settled with the carrier.

2-8. REPACKAGING FOR SHIPMENT.

2-9. If the instrument is to be shipped to an HP Sales/Service Office, attach a tag showing owner and owner's address, instruments model number and 8-digit serial number, and a description of service required.

2-10. The original shipping carton and packaging material, except for the accordian pleated pads, should be reused for shipment. If they are not available or reusable, the following material should be used:

Table 2-1. Shipping Carton Test Strength.

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 10	200
up to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

a. A double-walled carton (refer to Table 2-1 for test strength required).

b. Heavy paper or sheets of cardboard to protect all instrument surfaces (use a non-abrasive material such as polyurethane or a cushioned paper around all projecting parts).

c. At least 4 inches of tightly packed, industry approved shock absorbing material, such as an extra firm polyurethane foam.

d. Heavy duty shipping tape to secure outside of the carton.

2-11. INSTALLATION.

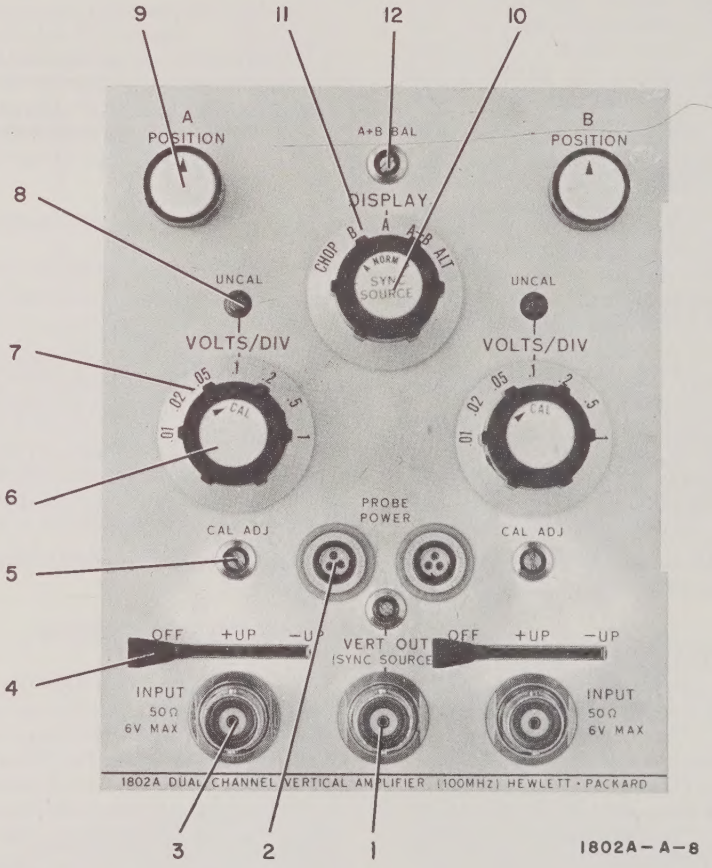
2-12. Dual Channel Vertical Amplifier, Model 1802A, is designed to slide jointly into position (with a horizontal plug-in) at the bottom of any Model 180-series Oscilloscope. Figure 2-1 shows the interconnection and coupling mechanism of each plug-in and associated Model 180-series mainframe. The following procedure tells how to incorporate this plug-in into the oscilloscope.

Step 1.
- a. Pull locking bar of horizontal plug-in to rear.
- b. Match connectors of vertical and horizontal plug-ins and engage by pressing together. (Make sure locking bar buttons are properly positioned.)
- c. When the plug-ins are joined, press locking bar forward to lock them together.

Step 2.
- a. Insert plug-ins into the Series 180 mainframe.

Step 3.
- a. When the assembly is fully in, swing the latch up and snap into place. (The assembly is now locked into the mainframe and ready for use.)

Before actual use, do the performance check in Section V to insure that the instrument operates according to specifications given in Table 1-1.



1. VERTICAL OUTPUT. Furnishes an amplified and inverted signal corresponding to selected SYNC SOURCE (A, NORM, or B).
2. PROBE POWER. Supplies +15 volts and -12.6 volts for operation of active probe.
3. INPUT. Accepts inputs up to ±6 volts from a 50-ohm source.
4. Polarity. Determines which polarity is displayed up, + or -, also terminates source with 50 ohms in OFF position.
5. CAL ADJ. Adjustment for VOLTS/DIV with vernier in CAL (detent) position.
6. Vernier (CAL). Provides a continuous adjustment between ranges of the VOLTS/DIV switch.
7. VOLTS/DIV. Selects the input amplitude necessary to produce one division of deflection.
8. UNCAL. When lighted, indicates that the vernier controls is not CAL (detent) position.
9. "A" POSITION. Moves the Channel A trace vertically to desired position on screen.
10. SYNC SOURCE. Selects horizontal sync signal (and VERTICAL OUTPUT) from Channel A or B only, or a combination as determined by the DISPLAY switch.
11. DISPLAY. Selects various display modes; e.g., CHOP, B, A, A + B, and ALT.
12. A + B BAL. Adjustment for dc balance between channels when in A + B operation.

Figure 3-1. Front Panel Controls

SECTION III
OPERATION

3-1. GENERAL.

3-2. This section provides information necessary for operating the Model 1802A Dual Channel Vertical Amplifier. Each control, connector or indicator function is explained briefly in Figure 3-1. Several operating setups are given to show equipment versatility and to familiarize the operator with typical measurement procedures.

3-3. CONTROLS AND CONNECTORS.

3-4. Although the functions described in Figure 3-1 are brief, they provide the operator with a quick reference with respect to operating function. Most controls are duplicated for Channel B; therefore, only those for Channel A are described. Several of the controls are discussed in more detail in the following paragraphs to ensure a thorough understanding of their function.

3-5. VERTICAL OUTPUT. This jack is connected to the output of the sync amplifier. It furnishes an amplified signal corresponding to the setting of the SYNC SOURCE control. When used for operation to increase vertical sensitivity, it should be realized that the display is inverted, unless Channel B polarity is set to - (minus).

3-6. CAL ADJ. Since there are slight differences in deflection from one CRT to another, it is necessary to provide the CAL ADJ for the operator to make the initial calibration adjustment. This screw driver adjustment physically moves the detent on the Vernier control while simultaneously making a fine vernier adjustment to bring the channel into calibration.

3-7. VERNIER (CAL). When this control is removed from its detent position, it provides a continuous adjustment of display amplitude by varying the input bridged T attenuation. By so doing, it enables the operator to use uncalibrated VOLTS/DIV to adjust a display to different amplitude.

3-8. VOLTS/DIV. Provides various fixed attenuations to the input signal by changing the selected combination of pi attenuators. Each channel has three pi attenuators which are connected in series with the input signal either individually or in combinations to produce the proper attenuation, and thus, the desired VOLTS/DIV display.

3-9. SYNC SOURCE. Although this switch is primarily used to select the signal source for generating a trigger in the horizontal sweep circuitry, it also indicates which signal is available at the VERTICAL OUTPUT jack.

3-10. DISPLAY. Selects one of five different display modes; CHOP, B, A, A + B, and ALT. Several of these modes have certain advantages when used for their particular purpose:

a. CHOP is beneficial when it is desired to show simultaneous A and B display for signals having long duty cycles or slow sweep speeds. During CHOP operation, small segments of Channel A and B are displayed alternately, therefore, both traces appear simultaneously.

b. ALT operation furnishes an alternating display of the A and B channel inputs. This mode is used with the higher sweep speeds where flicker is not noticeable, and where CHOP operation is too slow to produce a good display.

c. A + B operation causes the A and B channel input signals to be added algebraically, thereby, displaying a composite signal. This mode is beneficial when used to examine signals containing common mode noise (or 60 Hz), since it rejects the common mode voltage and displays only the desired signal.

3-11. INPUT PROBE.

3-12. The HP Model 1123A Voltage Probe is designed for use with the Model 1802A vertical plug-in to ensure a display with good response. When monitoring 50-ohm signal sources, the active probe is unnecessary, since the Model 1802A can be direct-coupled by a 50-ohm coaxial cable. Probe tip attenuators for the Model 1123A provide 10:1 and 100:1 attenuations which are necessary when checking signals larger than ±.5V. An additional probe tip allows viewing ac signals having large dc offset levels.

3-13. INTERNAL SYNC.

3-14. Sync signal output is determined by the setting of SYNC SOURCE control, which has three positions; A, NORM, and B. When set to either A or B, this switch provides a sync output signal corresponding to the vertical input signal. The NORM position furnishes a signal corresponding to the DISPLAY control, which has five settings; CHOP, A, B, A + B and ALT. Due to the unique arrangement of the SYNC SOURCE switch, many different internal sync modes are possible. When using the CHOP mode, a sync signal should be selected from either Channel A or Channel B to eliminate trigger interference generated by the chopping action. If it is necessary to sync on each channel separately, ALT may be used with SYNC SOURCE set to NORM.

3-15. OPERATION PROCEDURES.

3-16. To familiarize the operator with the versatility of the Model 1802A Dual Channel Vertical Amplifier, Figures 3-3 through 3-8 are provided. These figures contain an instrument picture and the procedural steps required to obtain proper operating conditions. Each control has a callout which corresponds to the step number of the procedure. It is assumed that the opera-

tor is familiar with the associated Model 180-Series Oscilloscope and how to obtain the proper horizontal sweep, etc. For some of the following operations, it is necessary to use AUTO SWEEP MODE and INT synchronization. Refer to Figure 3-2 for triggering requirements.

3-17. USE OF ACCESSORIES.

3-18. MODEL 1123A ACTIVE PROBE.

3-19. The HP Model 1123A is for use with the HP Model 1802A when a high input impedance is required. Input impedance of the Model 1123A is 100k ohms shunted by less than 3.5 picofarads and has a gain of 1:1 when used with the Model 1802A. Power is provided by a power jack on the 1802A front panel. A separate zero adjust in the probe amplifier allows the operator to select a zero volt reference level corresponding to zero volts at the probe tip. Bandwidth is greater than 100 MHz when driven from a 25-ohm source and greater than 60 MHz when driven from a 500-ohm source.

3-20. MODEL 10214A 10:1 DIVIDER.

3-21. The 10214A decreases the input sensitivity of the Model 1123A Probe by a factor of 10, permitting measurement of signals as large as ±5 volts peak-to-peak. The input impedance of the probe-divider combination is 1 Megohm shunted by 2.5 picofarads.

3-22. MODEL 10215A 100:1 DIVIDER.

3-23. The 10215A is similar to the 10:1 divider except that it attenuates 100:1 permitting measurement of signals up to ±50 volts peak-to-peak. Input impedance is 1 Megohm shunted by 3.5 picofarads.

3-24. MODEL 10217A BLOCKING CAPACITOR.

3-25. The 10217A allows measurement of signals which are ±50 volts from ground (±100 volts when used with the 10214A or 10215A). Lower cutoff frequency, when used with an 1123A Probe, is 1.6 kHz and 160 kHz when used with the divider tips. Probe input capacitance is increased no more than 3 pF.

3-26. MODEL 10228A BLOCKING CAPACITOR.

3-27. The 10228A serves the same purpose as the 10217A except that it extends the lower cutoff frequency to 12 Hz when used with the 1123A Probe and to 1.2 Hz when used with the divider tips. Input capacitance is increased by no more than 25 pF.

3-28. HOOK TIP.

3-29. The Hook Tip is a separately detachable probe tip which may be used for circuit connections which are not convenient for the standard probe tip, or when the operators hands must be free for adjustments.

3-30. MODEL 10020A RESISTIVE DIVIDER KIT.

3-31. The 10020A Divider Kit contains a set of 5 fixed division ratio tips for use with a 50-ohm input system such as the Model 1802A. Dividers and their characteristics are shown in Table 3-1. Input capacitance is less than .7 pF at the tip for all dividers.

Table 3-1. Resistive Dividers

Divider Ratio	Input Resistance	Max Input Voltage
5:1	250Ω	8V
10:1	500Ω	11V
20:1	1000Ω	15V
50:1	2500Ω	25V
100:1	5000Ω	35V

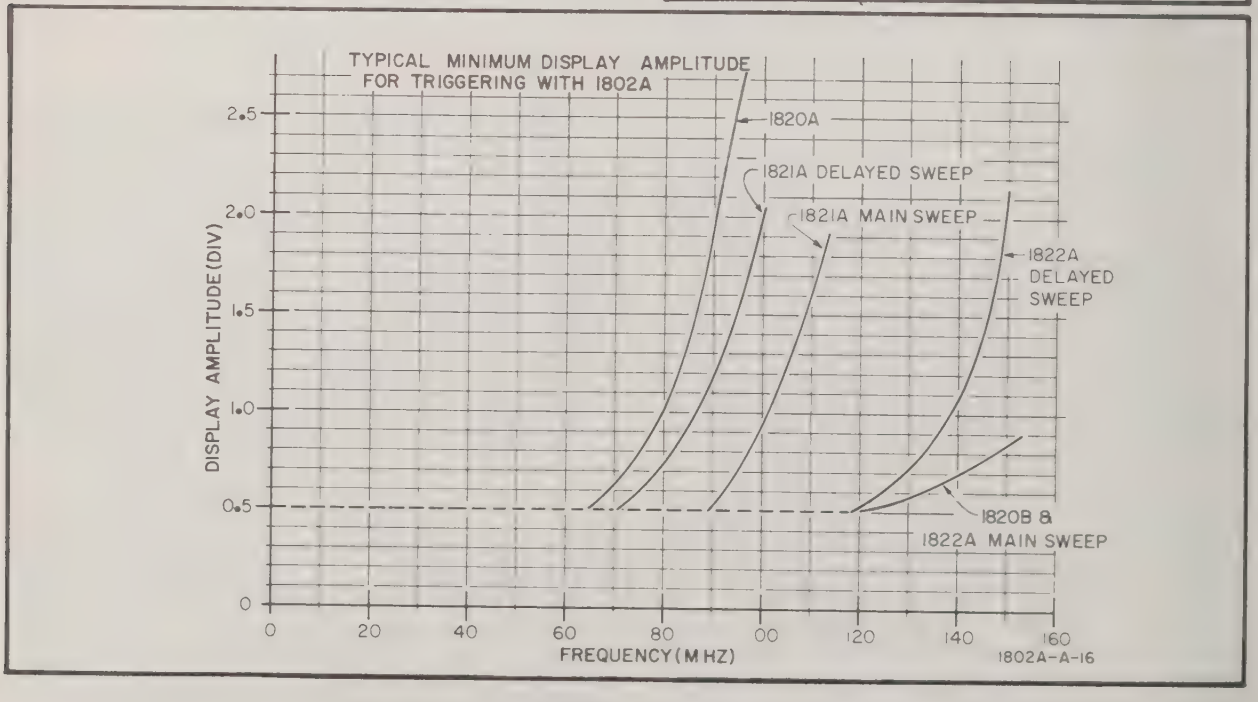
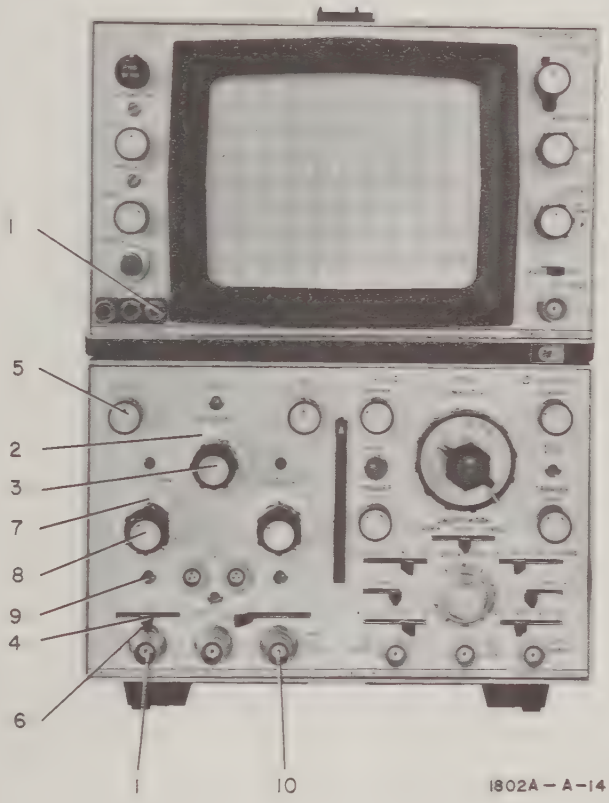
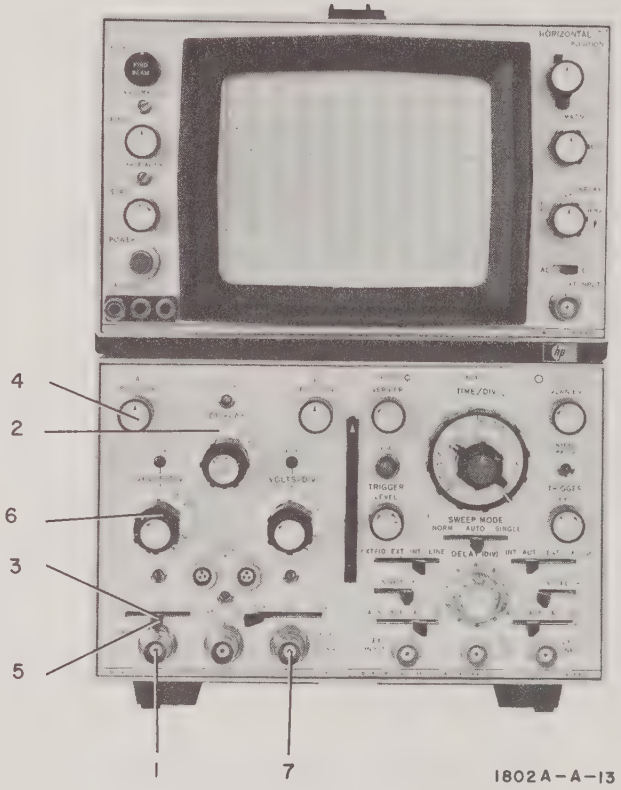


Figure 3-2. Model 1802A Triggering Requirements



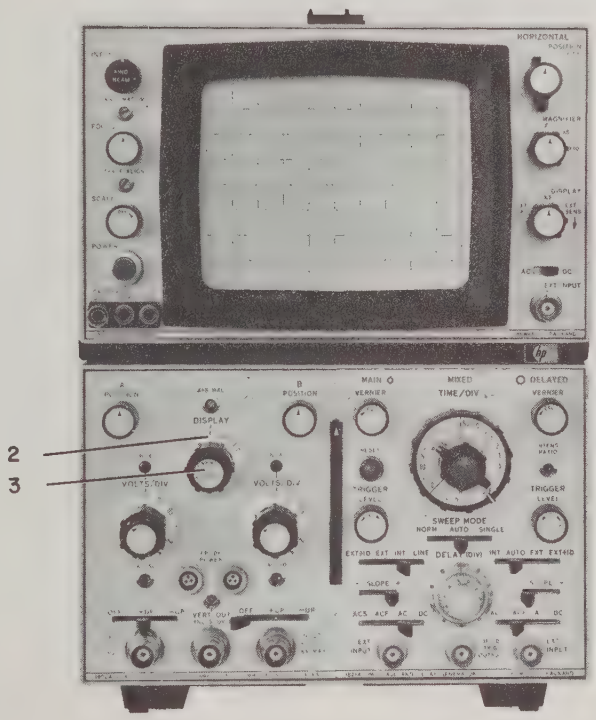
1. Connect Calibrate Adapter between INPUT A and Oscilloscope CALIBRATOR.
2. Set DISPLAY to A.
3. Set SYNC SOURCE to NORM.
4. Set Polarity switch to OFF.
5. Position horizontal trace on any graticule line above center.
6. Set Polarity switch to +.
7. Set VOLTS DIV to 0.01.
8. Set Vernier to CAL position.
9. Adjust CAL-ADJ for 5 divisions of deflection.
10. Repeat for Channel B.

Figure 3-3. Calibration Adjustment



1. Connect desired 50-ohm input signal to INPUT A.
2. Set DISPLAY to A.
3. Set A Polarity switch to OFF.
4. Establish a ground reference by positioning horizontal trace on center graticule line.
5. Set A Polarity switch to desired polarity.
6. Set Vernier to CAL and adjust VOLTS/DIV to obtain display.
7. For Channel B operation, set DISPLAY to B and use Channel B input.

Figure 3-4. Single Channel Operation (A or B).



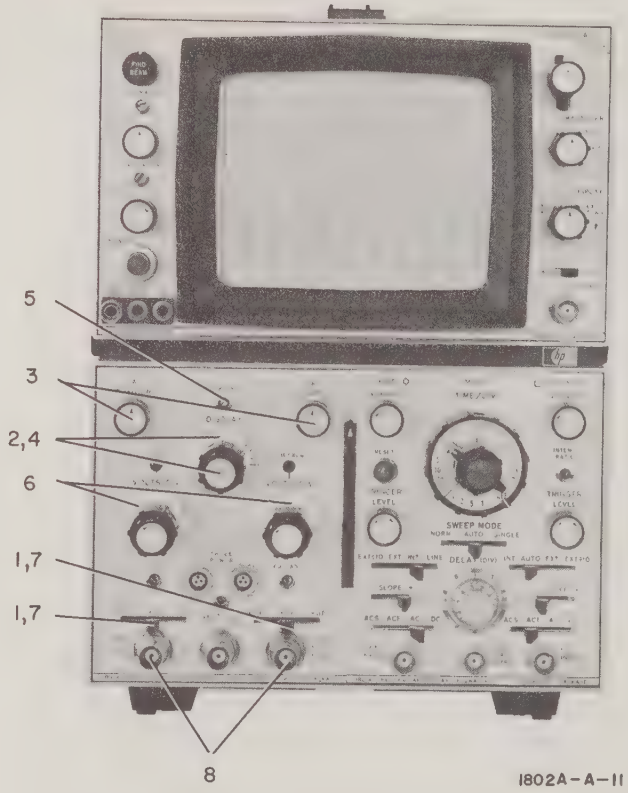
1. Perform procedure in Figure 3-4 for each Channel.
2. Set DISPLAY to CHOP or ALT (alternate) depending on sweep frequency.

Note

Since flicker is quite pronounced at slow sweep speeds, CHOP operation is recommended for settings below 1 MSEC/CM.

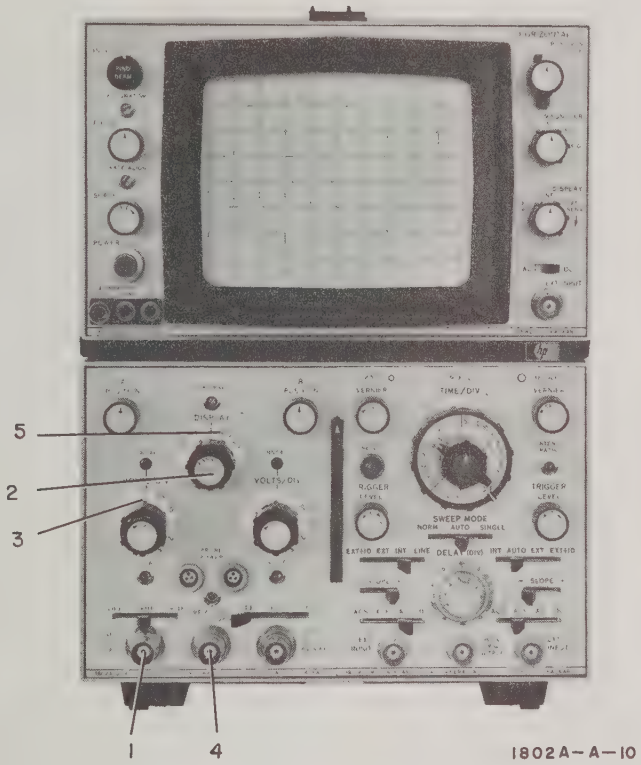
3. Set SYNC SOURCE selector to A or B.

Figure 3-5. Dual Channel Operation (CHOP or ALT).



1. Set both Polarity switches to OFF.
2. Set DISPLAY to ALT.
3. Position traces on center horizontal graticule line.
4. Set DISPLAY to A + B.
5. Adjust A + B BAL until trace is on center horizontal graticule line.
6. Set VOLT/DIV switches to same desired sensitivity.
7. Set Channel A and B polarity switches to +.
8. Connect INPUTS to signal source.
9. Set SYNC SOURCE to NORM for triggering on composite signal or to either A or B if sync on one signal only is desired.

Figure 3-6. A + B Operation

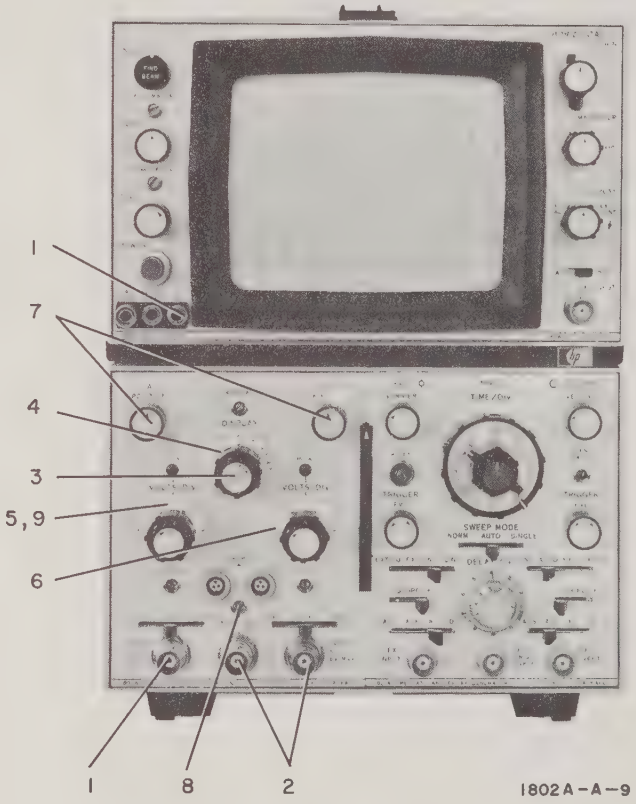


Note

Due to the SYNC SOURCE control feature, it is possible to use either sync channel as a wide band amplifier. The resulting OUTPUT is inverted and amplified approximately 10 times by the Sync Amplifier.

1. Connect the signal (from a 50-ohm source) to INPUT A (or B).
2. Set SYNC SOURCE control to correspond with input used.
3. Set VOLTS/DIV selector to desired sensitivity.
4. Connect VERT OUTPUT to desired 50-ohm load.
5. If the displayed mode is the same as the sync mode selected, the display will be the same as the Vertical Output.

Figure 3-7. Amplifier Operation



Note

When measuring or monitoring very small signals, cascade operation can be used to increase instrument sensitivity by 10 times; however, to produce positive (+) up displays, it is necessary to set Channel B Polarity switch to minus (-).

1. Connect the 1802A calibrator adapter between input A and 10V calibrator.
2. Jumper VERT OUTPUT to INPUT B with a short 50-ohm coaxial cable.
3. Set SYNC SOURCE switch to A.
4. Set DISPLAY switch to B.
5. Set Channel A VOLTS/DIV selector to 0.1.
6. Set Channel B VOLTS/DIV selector to .01.
7. Position display to desired screen location.
8. Adjust Vert Output for 5 divisions of deflection.
9. Set Channel A VOLTS/DIV to .01.
10. Disconnect calibrator adapter and connect the desired input to Channel A.

Figure 3-8. Cascade Operation

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains the theory of operation for the Model 1802A Dual Channel Vertical Amplifier. The text is divided into three subsections, (1) Simplified Circuit Theory, (2) Functional Description, and (3) Detailed Theory of Operation. Each typical component function is discussed once, either in the simplified theory or as it appears in the main signal path of the detailed theory. The Functional Description is discussed at block level for a quick overall understanding of the instrument.

4-3. SIMPLIFIED CIRCUIT THEORY.

4-4. In order to make the detailed theory of operation easier to understand, several of the circuits common to the Model 1802A are discussed in their simplified form. By so doing, the detailed text can then be used for discussing signal flow, controls, modifications to basic circuits, and the reasoning behind them. Basic circuits, and other basic networks are not discussed.

4-5. ATTENUATORS.

4-6. PI TYPE ATTENUATOR. A basic attenuator, such as the pi type shown in Figure 4-1A is quite common and used frequently in HP equipment. The purpose of an attenuator is to reduce the amplitude of a signal by some predetermined amount, thereby, increasing the dynamic range of the instrument. When the attenuator is used where impedance matching is critical in order to maintain optimum response, the network must perform both functions, fixed attenuation and impedance matching. The example chosen for Figure 4-1 is designed to match a 50-ohm source to a 50-ohm load while reducing the amplitude to one-half. In order to accomplish this task, the input of the attenuator when connected into the circuit must look like 50 ohms to the source, and conversely, the output of the attenuator must look like 50 ohms to the load.

4-7. To show that the attenuator will decrease the amplitude of an input across points A and B to one-half, it is necessary to calculate the equivalent resistance of R3 and the 50-ohm load in parallel. Since this value is equal to R2, the input signal is obviously divided equally across the two identical resistances; therefore, the output across points C and D is equal to one-half of the input. By performing additional calculations using the resulting equivalent resistance in conjunction with the other known values, it can be seen that the source will see 50 ohms across points A and B.

4-8. BRIDGED T ATTENUATOR. Like the pi attenuator, the bridged T attenuator (shown in Figure 4-1B) maintains an equal impedance between matched source and load while furnishing attenuation to the input signal. The amount of attenuation is determined by the resistive network of R1 through R4 and the source and load impedances. In a bridged T attenuator the resistance of R1 and R2 must be equal to the desired input and output impedance; therefore only the resistance of R3 and R4 need be calculated for any desired attenuation. The equations in Figure 4-1 are provided for calculations.

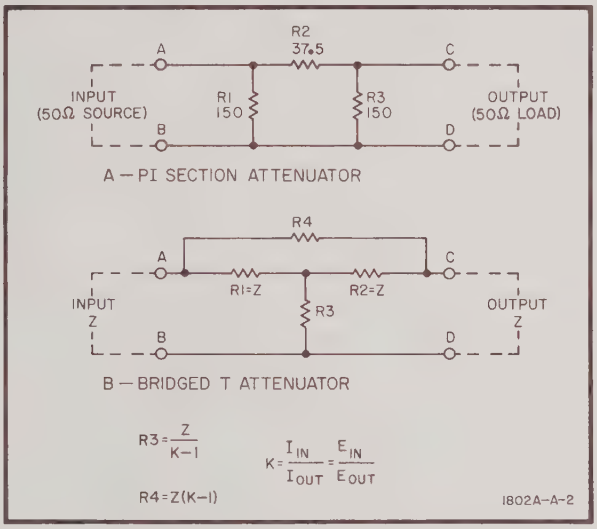


Figure 4-1. Simple Attenuator Networks

4-9. CASCODE AMPLIFIER.

4-10. A basic cascode amplifier consisting of common base stage Q2 driven by common emitter stage Q1 is shown in Figure 4-2. This combination makes it possible to achieve the frequency response and gain necessary for wide band operation.

4-11. High frequency response is normally restricted by the signal source impedance and Miller capacitance of Q1. Since the effects of Miller capacitance are amplified by the gain of the stage, it is detrimental in circuits having high voltage gain. Capacitive reactance of C1 decreases as frequency increases, effectively producing a large negative feedback which decreases signal gain. The Miller effect is reduced to a minimum by operating Q1 at a low voltage gain which is essentially a current amplifier operating into the low impedance input of a common base stage. High frequency response is then limited by base to collector capacitance, source impedance and the stray capacitance in the base circuit. Source impedance much smaller than the reactance of C1 at high frequencies gives maximum bandwidth.

4-12. Since the gain of a cascode amplifier tends to decrease at higher frequencies, the circuit is compensated with emitter peaking networks to maintain a constant gain over a wide range of frequencies. The gain of a cascode amplifier is approximately R_L divided by R_e at low frequencies. At high frequencies, where the reactance of C3 becomes significant, the emitter

impedance is R_e paralleled by the reactance of C3 which is smaller than R_e alone. The gain is then increased to be R_L divided by the reactance of the emitter circuit at higher frequency to compensate for the inherent high frequency loss of the amplifier.

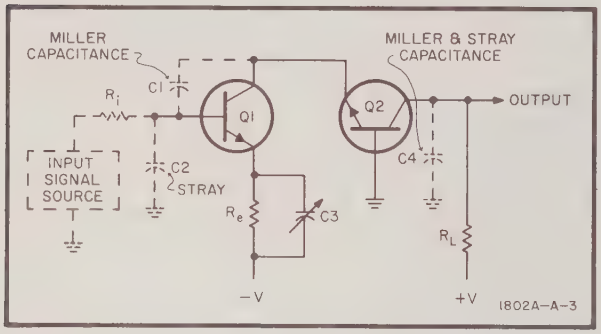


Figure 4-2. Cascode Amplifier

4-13. DIFFERENTIAL AMPLIFIER.

4-14. Figure 4-3 shows a basic differential amplifier. When a positive-going signal is applied to the A INPUT, the forward bias of Q1 is aided. A negative-going signal to the B INPUT applies a reverse bias to Q2. The voltage drops across R2 and R3 are equal and opposite as long as the input signals are equal. Thus, the output signal is the amplified difference between the two input signals. If R1 is large enough to approximate a current source, inputs of the same polarity will not cause opposite current changes through R2 and R3 and no output will be developed. Thus, only the difference in voltage between the two inputs is amplified and common mode signals are rejected at the output.

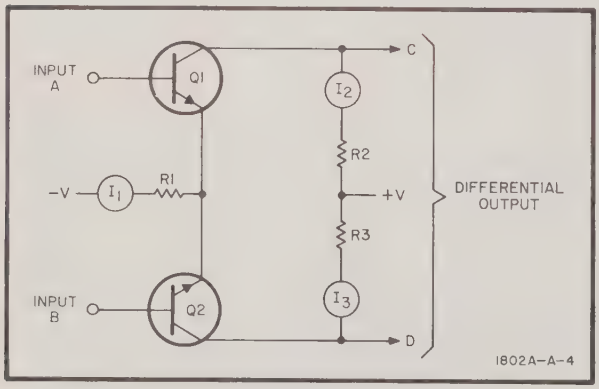


Figure 4-3. Differential Amplifier

4-15. MULTIVIBRATORS.

4-16. BISTABLE MULTIVIBRATOR. Figure 4-4 shows a basic Bistable Multivibrator. With the addition of several components, the Bistable Multivibrator must be switched by means of a trigger input. Assume that after power is applied, Q1 begins conducting. With Q1 conducting, CR1 is forward biased and CR2 is reverse biased. The trigger input then is fed to the base of Q1 as reverse bias. A positive-going signal at the collector of Q1 is fed to the base of Q2 as forward bias and Q2 is turned on. The Bistable Multivibrator will remain in this new state until another trigger input is received.

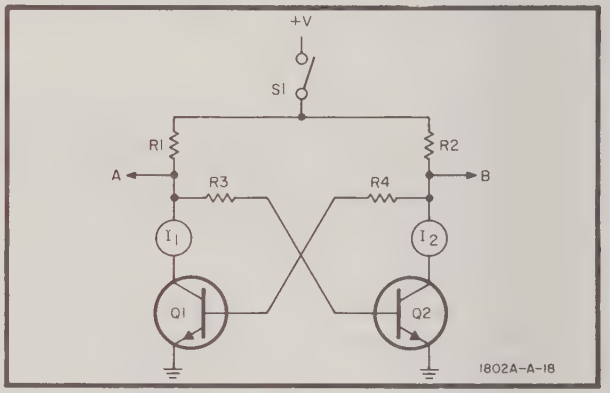


Figure 4-4. Bistable Multivibrator

4-17. ASTABLE MULTIVIBRATOR. An Astable Multivibrator is a two-stage free-running generator used to produce a square wave. Figure 4-5 shows an Astable Multivibrator in its simplest form. Both transistors start to conduct when voltage is applied. Although components in each stage are of the same value, some slight difference in tolerance will make one transistor conduct sooner than the other. Assume that Q1 begins to conduct first. A voltage is dropped across R1 and the collector of Q1 goes positive. This causes C1 to charge, bringing the base of Q2 in a positive direction. Thus Q2 is reverse biased and conduction is reduced. With Q2 conducting less, the collector goes more negative and capacitor C2 charges to bring the base of Q1 more negative also. As conduction increases in Q1, it decreases in Q2 until cutoff is reached. At this point, C1 discharges through R3 and makes the base of Q2 negative. As the collector of Q2 goes in a positive direction, C2 charges causing Q1 to go into cutoff. The process is repeated continually turning on one transistor and then the other. The square wave output can be taken from either collector, although each output is 180° out of phase. Frequency of the square wave output is determined by the component values of C1, R3 and C2, R2.

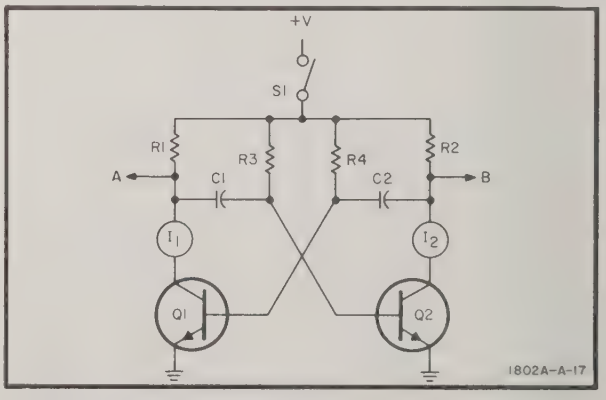


Figure 4-5. Astable Multivibrator

4-18. FUNCTIONAL DESCRIPTION.

4-19. Figure 4-7 is a functional block diagram designed to show the signal flow through the Model 1802A.

4-20. This amplifier is designed to accept vertical signals at INPUT A and B. To accommodate a wide dynamic range of voltage, each input has an attenuator which reduces the signal amplitude to the Input Amplifier. Each channel is attenuated separately; therefore, vertical signals with wide voltage differences can be accepted simultaneously. Also, each channel has a polarity switch which allows the user to view either positive (+) signals up or negative (-) signals up. In the OFF position, these switches disconnect their respective inputs and terminate the inputs with 50 ohms.

4-21. After attenuation and desired polarity selection, the input signals are amplified and distributed to both Vertical Channel Amplifiers and the Sync Channel Amplifiers. Position controls connected to the Vertical Amplifiers provide positioning of the two signals to any desired screen location. Immediately following the Input Amplifiers are diode gating networks which determine which signal or combination of signals is displayed on the CRT. The selected vertical signal is routed through a delay line, amplified by the Vertical Output Amplifier and applied to the CRT vertical deflection plates.

4-22. The vertical signal is delayed approximately 160 ns by the delay line, giving the Sync Amplifier sufficient time to provide a sync output before the vertical signal is applied to the deflection plates. This allows the sweep to be started slightly before the vertical signal reaches the plates and permits viewing of the leading edge of the signal.

4-23. Following the Input Amplifier is a gating network for the Sync Amplifier which allows the operator to select a sync output which is independent of the displayed vertical signal. The selected signal is amplified and used as a sync signal to the time base plug-in and also applied to the front panel as an inverted vertical output.

4-24. MODES OF OPERATION.

4-25. The DISPLAY control lets the operator select any of five modes of display operation: (1) CHOP, used for reducing flicker while simultaneously viewing displays of two signals having slow repetition rates, (2) B Channel alone, (3) A Channel alone, (4) A + B, used for summing both channels or eliminating the common mode components from the two inputs (A - B) and (5) ALT, used for the apparent simultaneous display of two signals having fast rep-rates. When only one channel is selected, the switching multivibrator is forced to one stable state which produces a switching signal to the diode gating network for the desired signal. For ALTERNATE operation, the multivibrator is triggered by the CRT blanking pulse, causing the vertical signal to be selected alternately from Channel A or Channel B. During CHOP operation, however, the multivibrator is allowed to free run causing small segments of each channel to be displayed during each sweep. Due to the nature of CHOP operation, it is necessary to provide a blanking signal to turn off the beam during the transitions between Channel A and Channel B.

4-26. DETAILED THEORY OF OPERATION.

4-27. The following paragraphs discuss detailed theory of circuits as they appear in the main signal path. This instrument contains two identical Vertical channels and two identical Sync channels; therefore, only one of each typical circuit is discussed.

4-28. VERTICAL INPUT ATTENUATORS.

4-29. To insure maximum frequency response in the Vertical Amplifier, impedance matching between the source and input is necessary. The Vertical Amplifier is designed with a 50-ohm input impedance to facilitate direct observation of systems which have 50-ohm input/output impedances. Maximum range is maintained by switching the attenuator for inputs up to ±6.0V.

4-30. Three pi sections and one variable bridged T attenuator are used in various combinations to furnish desired attenuations. Figure 8-6 shows this switching arrangement. The bridged T attenuator is in series with the selected pi section combination, and provides the calibration adjustment (CAL-ADJ) necessary when changing the plug-in from one mainframe (Model 180-Series) to another. By the use of two ganged logarithmic tapered potentiometers (A1R12 and R13), it is possible to vary the attenuation for UNCAL operation, yet maintain a constant 50-ohm impedance match from input connector to Input Amplifier.

4-31. The bridged T attenuator keeps input/output impedance constant by causing R12 to increase in value while R13 decreases in value. Although the input/output impedance is constant, the variations in value of R12 and R13 change the overall attenuation of the input signal. To calibrate the Model 1802A, the CAL ADJ moves the detent of the Vernier, thereby making use of part of the range of the bridge T attenuator. It is necessary to readjust the CAL ADJ to compensate for differences in CRT deflection from one mainframe to another.

4-32. POLARITY SWITCH.

4-33. To provide the option of viewing positive or negative up, or to disconnect the signal from the Vertical Input Amplifier, a Polarity Switch is added in series with each channel's signal path. When "+" is selected, positive signals are displayed up, and when "-" is selected, negative signals are displayed up. In the OFF position the signal input from the attenuator and each side of the Input Amplifier is terminated with 50 ohms. This is to maintain a constant impedance match and, thereby, eliminate possible reflections due to mismatch.

4-34. VERTICAL INPUT AMPLIFIER.

4-35. Dual transistor A3Q1A/B receives the attenuated vertical input signal from the polarity network (see Figure 8-9). A dual transistor is used here because of its closely matched gain characteristics and close temperature tracking which insures minimum offset. Both A3Q1A and B are one-half of two Cas-

code Amplifiers; e.g., in conjunction with A3Q2A and B, each forms a Cascode Amplifier for the Sync B Channel and A4Q1A and B form the Vertical B Channel.

4-36. Although the vertical signal is traced through the vertical channels in the following paragraphs, the Cascode Amplifiers consisting of A3Q1A/B and A3Q2A/B are discussed here because they are identical. (Figure 8-9).

4-37. POWER MATCHING. Transistors A3Q1A and B are at the front end of both Sync and Vertical Amplifiers; therefore, and offset introduced at this point is amplified causing erroneous display. As previously mentioned, A3Q1A and A3Q1B have matched gain and are contained in a single case. Dual transistors tend to operate at approximately the same temperature; however, when connected in a differential configuration, one or the other usually conducts more, thus raising its power dissipation and causing thermal drift. To prevent this, power matching networks are added to the collector circuit of each transistor.

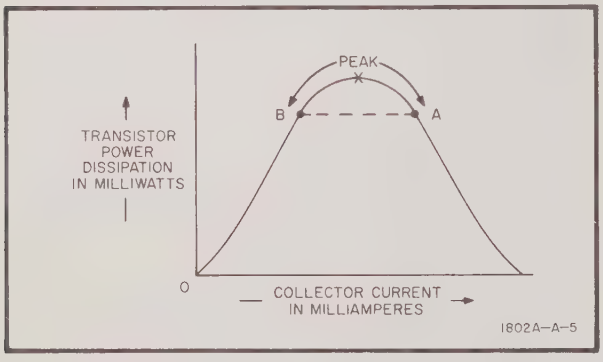


Figure 4-6. Transistor Power Curve

4-38. In order to obtain a power match between A3Q1A and Q1B, it is necessary to set up a condition where each transistor is operating at its power peak while in the quiescent state (see Figure 4-6). To accomplish this, resistors A3R15 and R16 and A3R11 and R12 are selected so that an increase or decrease in current through either A3Q1A and A3Q1B causes transistor power dissipation to decrease. For example, when current increases in Q1A its power dissipation moves forward and down the power curve, while simultaneously the decrease in current in Q1B causes its power dissipation to move backward and down the power curve. Since these power points essentially track each other in magnitude, transistors Q1A and Q1B always operate at equal powers, thus, minimizing thermal drift.

4-39. IMPEDANCE MATCHING. To maintain maximum response at high frequencies, the impedances at the common base stages of A3Q2A and B, and those of A4Q1A and B in the Vertical Channel, are carefully matched to provide 50 ohms of resistance in each leg of the 100-ohm line. Resistors A3R17/18 in series with the emitter/base resistance of A3Q2A and B furnish the right value in the Sync Channel, and resistors A4R3 and A4R4 in series with the emitters A4Q1A and B and accomplish it in the Vertical Channel (Figure 8-12).

4-40. GAIN DETERMINATION. The voltage gain of either Cascode Amplifier stage is approximately equal to the ratio of its collector and emitter resistances. For example, in the Cascode Amplifier consisting of A3Q3 and A3Q9A, the gain is set essentially by the ratio of A3R80 to one-half the value of A3R32. The resistors in series with the collector current of A3Q3 (R33 and R106) have virtually no effect on stage gain.

4-41. VERTICAL POSITIONING. Positioning of the Channel B signal is controlled by potentiometer R10 which is mounted on the front panel. This control simply introduces an offset bias current which in turn causes the VERTICAL OUTPUT and CRT trace to move up or down (see Figure 8-12). To insure that the POSITION control is centered with CRT trace centered, balance control A3R6 is used. To assure that the VERTICAL OUTPUT is at zero when the position and CRT trace are centered, sync balance adjust (A3R30), is used.

4-42. VERTICAL AMPLIFICATION. The amplified vertical signal is direct-coupled to the base of Differential Amplifier, A4Q2 and A4Q3, enroute to the delay line and vertical output stages. Voltage gain in this stage is kept low to prevent amplification of the Miller effect. As with the first Cascode Amplifier stage this too has emitter peaking (C7 and R16) to compensate for gain changes at high frequencies.

4-43. CHANNEL SWITCHING.

4-44. The vertical signal is amplified by a second cascode Differential Amplifier (A4Q4/A4Q11 and A4Q5/A4Q12) immediately following the Differential Amplifier stage just discussed (see Figure 8-12). This time, however, the second half (common base amplifier) is common to both Vertical Channels A and B. Since the input to a Common Base Amplifier is a low impedance, it is an ideal location to insert the channel switching diodes, A4CR1 through A4CR8.

4-45. Examine the connections of diodes A4CR1 through A4CR4. Notice that CR3 and CR4 are connected in series with the signal flow and will pass the vertical signal to A4Q11 and A4Q12. The bases of Q11 and Q12 are at approximately +5 volts due to VR1. The emitters of these transistors are near +5.7 volts; i.e., during operation the anodes of CR3 and CR4 are approximately +5.7 volts. When these diodes are conducting, they drop 0.7 volts causing their cathodes to assume about +5 volts. If Channel B switching input (90 wire) to the junction of CR1 and CR2 is at 0V, these diodes are reverse-biased, effectively removing them from the circuit. All vertical signals applied to Channel B are amplified and directed to the Output Amplifiers. However, when the switching input goes positive, CR1 and CR2 are forward biased, clamping the signal path to a positive voltage. Transistors Q4 and Q5 continue to conduct; but, due to the reverse-bias on CR3 and CR4, the signal path is open beyond this stage for Channel B. Switching is controlled so that when one channel is off the other will be on.

4-46. A + B OPERATION. It was previously mentioned that when CR1 and CR2 were forward-biased, Channel B signal path was opened. Due to the arrangement of the channel switching circuitry, Channel A would be on during this time. For A + B operation, however,

both Channels A and B are on simultaneously. In this instance, both channel signals are summed at the emitters of Q11 and Q12. To compensate for offset caused by the bias of both channels operating simultaneously, A + B BAL potentiometer R11 is used to compensate the bias on Q11 and Q12.

4-47. DELAY LINE.

4-48. The Delay Line is inserted in series with the vertical signal path to delay the vertical signal. The delay in the Vertical Channel is enough to allow the sweep to start before the signal arrives at the vertical deflection plates. Without this delay, it would be impossible to observe leading edge of single pulses or transitions.

4-49. The Delay Line used in the Model 1802A has an impedance of 180 ohms and delays the signal 160 nanoseconds. Impedance matching is important; therefore, resistors A4R62 and R63 are used to provide proper matching on the input side of the Delay Line. Resistors R13 and R14 provide matching at the output to insure impedance matching and minimum reflection.

4-50. VERTICAL OUTPUT.

4-51. Subsequent Differential and Cascode Amplifier stages, similar to those already discussed, are used prior to the output transistors Q1 and Q2. Each of these stages provides gain, and each common emitter stage contains emitter peaking to compensate for high frequency roll-off. In addition, amplifier stage A4Q21 and Q22 is controlled by the BEAM FINDER connection at the junction of A4CR9/CR10. The BEAM FINDER lead normally supplies -12.6V to this junction. When the BEAM FINDER is depressed this point is disconnected, decreasing the gain and current in amplifier A4Q21/Q22. This restricts the CRT display regardless of input signal. Transistors A4Q23 and A4Q25 provide a voltage step up to attain the high DC level required at the base of Q1. Transistors A4Q24 and A2Q26 operate identical for Q2.

4-52. SYNC AMPLIFIER.

4-53. The Sync Amplifier contains circuits which are essentially the same as the Vertical Amplifier; therefore, only the differences are discussed (see Figure 8-9). A major difference is in the sync output stages. Each half of the differential sync signal is amplified and supplied to a separate output driver stage.

4-54. SYNC OUTPUT DRIVER. Transistor A3Q15 is an Emitter Follower which supplies a sync signal to the horizontal trigger generator via connector J6. Diode A3CR13 in the base bias circuit provides temperature compensation to minimize thermal drift. Emitter resistor A3R99 and inductor A3L4 maintain an impedance match to the cable in the horizontal plug-in. Collector resistor A3R101 minimizes the change in power dissipation for A3Q15, thereby helping to decrease thermal drift.

4-55. VERTICAL OUTPUT DRIVER. This output Driver works identical to the Horizontal Sync Output driver, except the VERTICAL OUTPUT is connected to front panel connector J5 through a variable attenuator and provides a signal for use with other related instruments. Peaking circuits in the sync amplifier insure good response to both the horizontal sync output and the VERTICAL OUTPUT. Good response is necessary in the sync amplifier to insure good results when the VERTICAL OUTPUT is cascaded with the Vertical Amplifier and for stable triggering.

4-56. CASCADE OPERATION.

4-57. When additional sensitivity is required, Channels A and B may be cascaded to use the gain available from both in series. Figure 3-8 gives the recommended cascade connection.

4-58. During normal operation, the signal levels dealt with at the inputs of Channel A and B Input Amplifiers are relatively small; however, when using the cascade mode, the amplifier signal applied to Channel B INPUT from the VERTICAL OUTPUT has been amplified by Channel A Sync Amplifier. Since Channel B Sync Amplifier is not used during this operation, its channel switching diodes are reverse-biased.

4-59. CHANNEL SWITCHING.

4-60. Channel Switching Assembly A5 (see Figure 8-18) performs two important functions: (1) it furnishes switching voltages to the Vertical and Sync Channel switching diodes, and (2) it produces a chopped blanking signal for use in the associated horizontal time base.

4-61. SWITCHING MULTIVIBRATOR. (Refer to Figure 8-18 for the following discussion.) Due to the various switching modes required in the Model 1802A Switching Multivibrator A5Q1/Q2 functions as a bistable multivibrator during ALT, A, and B operation and as an astable multivibrator during CHOP operation. For A + B operation, it acts as two separate saturated Common Emitter Amplifiers.

4-62. The various switching modes are initiated by DISPLAY switch S1 which controls the action of the multivibrator (A5Q1 and A5Q2). For example, in the position shown (ALT) switch S3-1F furnishes a negative operating voltage to the collector circuits of A5Q1 and A5Q2, switches S3-1R and S3-2R connect positive-bias to the base circuits of A5Q1 and A5Q2, and switch S3-2F provides ground to the trigger input circuitry. Under the above conditions, the multivibrator is ready to accept alternate trigger pulses via instrument connector P1 and cable W8.

4-63. As explained in the simplified circuit theory, each negative going trigger pulse causes the multivibrator to change state. Multivibrator outputs are amplified by Differential Amplifier A5Q3/Q4. The resulting output voltages at the emitters of A5Q5 and A5Q6 are used to control the channel switching diodes in the Vertical and Sync Amplifiers.

4-64. VERTICAL SWITCHING. The vertical channel switching diodes are connected directly to the switching voltages, therefore always providing switching as indicated on the DISPLAY switch.

4-65. SYNC SWITCHING. Switching voltages for the Sync Channel switching diodes are taken from the SYNC SOURCE switch (S4) and depend on the switch setting. Regardless of the mode selected by the DISPLAY

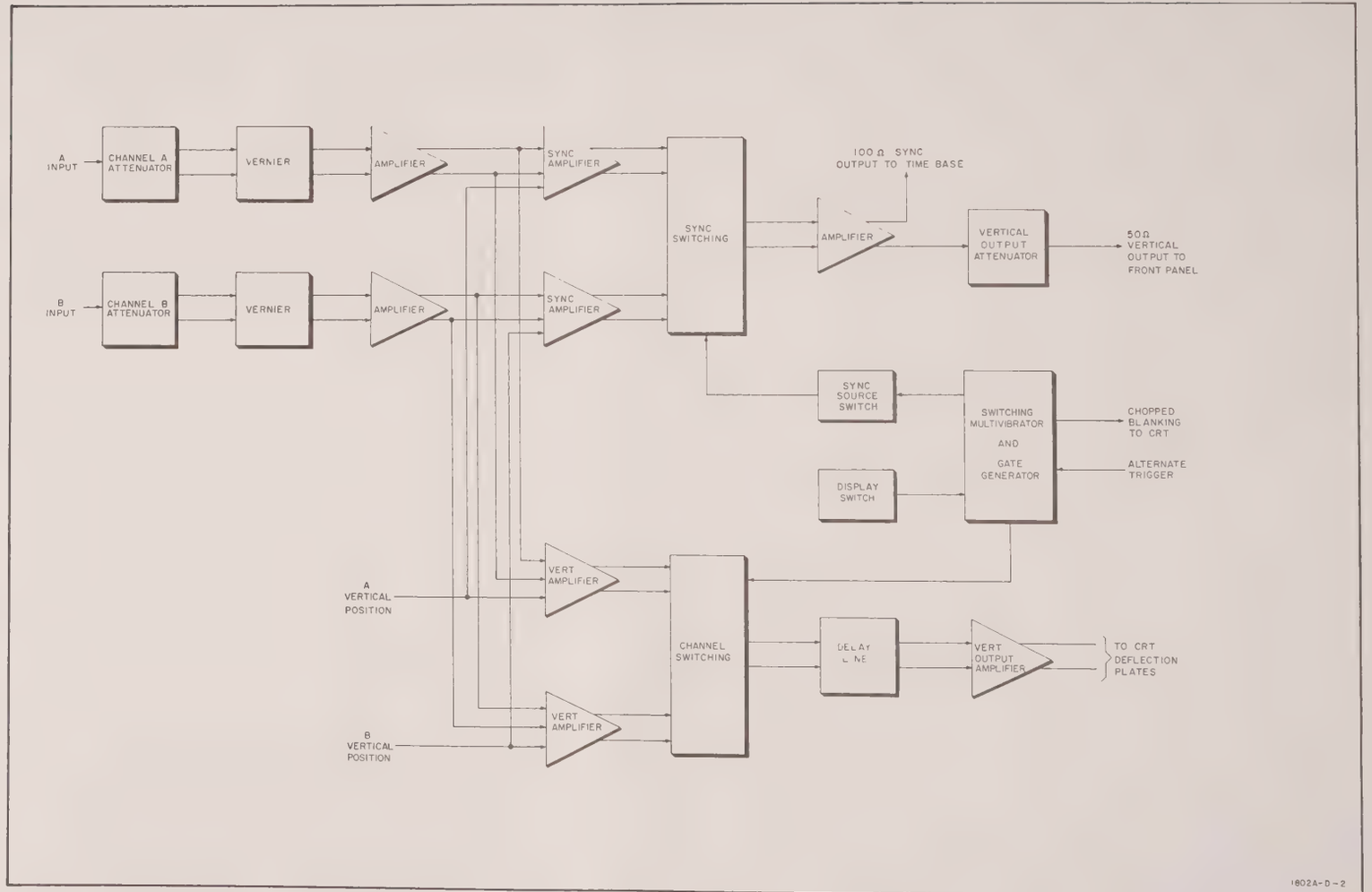


Figure 4-7. Overall Block Diagram

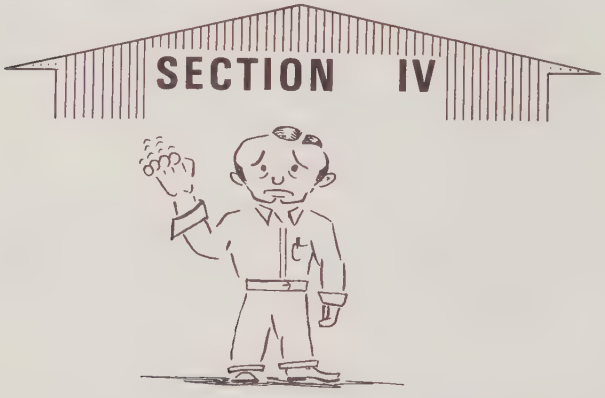
switch, the SYNC SOURCE switch allows the operator to sync on B only, A only, or the composite signal (NORM) indicated on the DISPLAY switch.

4-66. CHOPPED BLANKING.

4-67. The Chopped Blanking Amplifier consists of A5Q7 and A5Q8. Isolation input diodes CR9 and CR10 are reverse-biased by a positive potential through R29 and R30 in all modes except CHOP. At this time, ground is applied to the top of R30 by the DISPLAY switch (S3-3R) allowing CR9 and CR10 to pass positive pulses from A5Q5 and A5Q6. Common Emitter Amplifier Q7 amplifies the pulses which are coupled through C9 to a second amplifier, Q8. The chopped blanking signal is then coupled by coax cable W9 to the instrument connector P1, where it is applied to the oscilloscope blanking circuitry.

4-68. POWER SUPPLY DECOUPLING.

4-69. Each printed circuit assembly has several decoupling networks for the supply voltages used on the boards. Decoupling is important to prevent noise from entering the Vertical Amplifier circuitry from the supplies. Conversely, they are equally important for keeping transients generated in the Vertical Amplifier from getting back to the power supply. An example of the decoupling used in these circuits is shown on Figure 8-9. There are two decoupling networks on both the -12.6 volts and +15 volts. One decoupled source of each is used for the preamplifier circuits and the others are used for the sync output amplifier circuit.



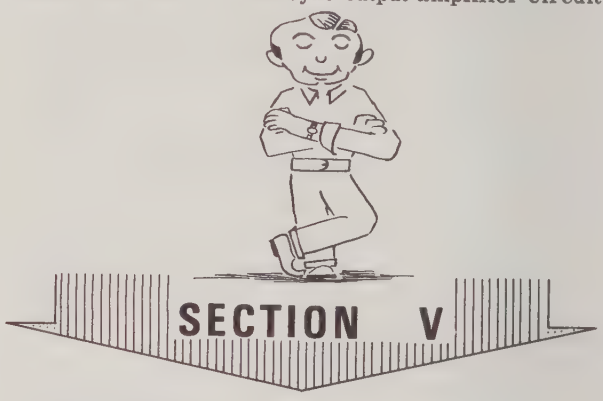


Table 5-1. Required Test Equipment

Recommended Instrument		Required Characteristics
Type	Model	
Generator/Sweeper	HP 8601A	100 MHz - 1V pk-pk ±1%
Autovoltmeter	HP 414A	10 mV - 100 vdc ±1% accuracy
VHF Oscillator	HP 3200B	10 MHz - 110 MHz 3V pk-pk
RF Millivoltmeter	HP 411A	10 mV - 10V rms ±6%
Square Wave Generator	HP 211B	Risetime 20 nsec 60 mV - 30V
Constant Amplitude Signal Generator	Tektronix Type 191A	1 MHz - 100 MHz 4V pk-pk
Pulse Generator	HP ET-2266	Risetime 1 nsec Amplitude 6V

Accessories Required:

(1) 50 ohm termination HP Model 10100A
(2) 10:1 Divider Probes HP Model 10003A/B
(1) Plug-In Extender HP Model 10407A
(1) 200:1 Attenuator HP Part No. 01802-63201
(1) 50 ohm Power Splitter HP Model 11549A
(1) 10 dB Pad GR 874 G10

SECTION V
PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section contains procedures for performance checks and adjustments. The purpose of this information is to insure whether or not the instrument is operating within the specifications listed in Table 1-1, and if not, how to calibrate the instrument. Physical location of all internal adjustments is shown in Figure 5-2. Troubleshooting information, component locations, and schematic diagrams are in Section VIII.

5-3. TEST EQUIPMENT.

5-4. Test equipment required to check and maintain this instrument is listed in Table 5-1. Similar or equivalent test equipment may be used if necessary. A non-metallic alignment screwdriver must be used for making the required adjustment.

5-5. PERFORMANCE CHECK.

5-6. The purpose of this performance check is to determine whether or not the instrument is operating within its listed specifications. This check can be used as part of an incoming quality control inspection, a periodic operational check, or to check calibration after repair and/or adjustments are made.

5-7. Enter the readings of the initial performance check on the Performance Check Record on Page 5-4a/b. The form may then be removed from this manual and filed in a safe place so that readings taken at a later date can be compared to the original readings.

5-8. It is recommended that the performance check be done in the sequence given because succeeding steps depend upon control settings and results of previous steps. Steps may be done individually by referring to initial control settings prior to the desired step.

5-9. PRELIMINARY SET-UP.

5-10. Lock the plug-ins together and install in a 180-Series Oscilloscope mainframe.

5-11. INITIAL CONTROL SETTINGS.

a. Model 180-Series Oscilloscope:

HORIZONTAL DISPLAY . . . . . INT
HORIZONTAL MAGNIFIER X1
INTENSITY . . . . . Normal

b. Time Base plug-in:

Sweep Time . . . . . .5 MSEC
SWEEP MODE . . . . . AUTO
Trigger Source . . . . . INT

c. Model 1802A Dual Channel Vertical Amplifier:

A Polarity . . . . . +UP
B Polarity . . . . . +UP
DISPLAY . . . . . A
Vernier . . . . . fully cw
SYNC SOURCE . . . . . NORM

5-12. GAIN CHECK.

a. Connect the output from the 10V CALIBRATOR of the 180-Series Oscilloscope through the 200:1 attenuator to the Channel A INPUT.

b. Adjust Trigger Level for stable display.

c. Observe vertical deflection of approximately 5 div.

d. Connect output of ET 2266 to Channel A INPUT.

e. Set ET 2266 and VOLTS/DIV controls according to Table 5-2 and observe vertical deflection.

Table 5-2. Amplifier Gain

ET 2266 Attenuation	Volts/Div	Vertical Deflection
X100	.01	Note Reading
X50	.02	± 3%
X20	.05	± 3%
X10	.1	± 3%
X5	.2	± 3%
X2	.5	± 3%
X1	1	± 3%

f. Repeat above procedure for Channel B.

5-13. VERNIER CHECK.

a. Set ET 2266 Attenuation to X1 and Channel A VOLTS/DIV to 1.

b. Connect ET 2266 to Channel A INPUT

c. Rotate Vernier fully ccw.

d. Signal amplitude shall decrease to less than deflection noted divided by 2.5.

e. Repeat steps a through d for Channel B.

5-14. POLARITY CHECK.

a. Set controls as follows:

DISPLAY . . . . . A
A Polarity . . . . . +UP

b. Center trace using Channel A POSITION control.

c. Apply 10V CALIBRATOR signal to Channel A INPUT through HP 200:1 divider.

d. Observe square wave appearing in the lower half of the CRT with its baseline on the center graticule line.

e. Switch Polarity to - and repeat steps b through d.

f. Switch DISPLAY to B and repeat steps b through e.

g. Observe square wave appearing in the upper half of the CRT with its baseline at center of graticule.

5-15. COMMON MODE REJECTION CHECK.

a. Set controls as follows:

DISPLAY . . . . . A
Channel A VOLTS/DIV 01
Channel B VOLTS/DIV 01
A Polarity . . . . . +UP
B Polarity . . . . . -UP

b. Apply 1 MHz input from Tek 191 to Channel A and B INPUT using two equal length cables and a 50-ohm Power Splitter.

c. Adjust output of Tek 191 for 8 div display.

d. Switch DISPLAY to A + B.

e. Observe deflection of .4 minor div or less.

f. Switch A INPUT Polarity to - and B INPUT Polarity to +.

g. Repeat step e.

h. Repeat steps a through h for both channels using 100 MHz except set amplitude for 6 division vertical deflection.

i. Observe deflection of 3 minor div or less.

5-16. CROSSTALK CHECK.

a. Set controls as follows:

DISPLAY . . . . . CHOP
A Polarity . . . . . +UP
B Polarity . . . . . +UP

b. Apply output of HP 211B to Channel A INPUT.

c. Set frequency and observe deflection as specified in Table 5-3.

Table 5-3. Crosstalk

HP 211B	Input	Vertical Deflection
10 kHz	6 div	1 minor div
50 kHz	6 div	1 minor div
100 kHz	6 div	1 minor div
1 MHz	6 div	1 minor div
10 MHz	6 div	1 minor div

d. Repeat steps b and c for Channel B.

5-17. TRIGGERING CHECK.

a. Set controls as follows:

DISPLAY . . . . . A
VOLTS/DIV . . . . . 20 mV
A Polarity . . . . . +UP
POSITION . . . . . centered
TRIGGER . . . . . NORM

b. Apply 10V CALIBRATOR to Channel A INPUT through a 200:1 divider.

c. Using a 180-Series Oscilloscope, monitor the VERT OUTPUT using a terminated 50-ohm load.

d. Make settings and observations as specified in Table 5-4.

Table 5-4. Triggering

Trigger Selection	Sync Output
NORM	.25 volts pk-pk
A	.25 volts pk-pk
B	0 volts

e. Repeat steps b through d above for Channel B except .25V should be observed on Channel B.

5-18. PULSE RESPONSE CHECK.

a. Set controls as follows:

DISPLAY . . . . . A
A VOLTS/DIV 01
A Polarity . . . . . +UP
HORIZONTAL MAGNIFIER X1

b. Apply output of ET 2266 to INPUT of Channel A.

c. Set amplitude for 6 div deflections as displayed on the CRT.

d. Switch HORIZONTAL MAGNIFIER to X10.

e. Observe 3.5 minor div (3.5 ns) or less risetime.

f. Overshoot, undershoot or perturbation should be less than 0.9 minor div (3%).

g. Repeat steps b through f for Channel B.

5-19. BANDWIDTH CHECK.

a. Set controls as follows:

DISPLAY . . . . . A
A Polarity . . . . . +UP
A VOLTS/DIV 01
TIME/DIV . . . . . .1 μSEC

b. Connect the output of the 8601A Sweeper through a 10 dB pad to the Channel A INPUT.

c. Set frequency of the 8601A to 1 MHz.

d. Adjust output for 8 div display on CRT.

e. Increase the frequency to 100 MHz.

f. Observe a display of greater than 5.6 div in amplitude.

g. Repeat steps b through f for Channel B.

5-20. ADJUSTMENTS.

5-21. The purpose of the adjustment procedure is to establish proper calibration so the instrument will perform as stated in the specifications listed in Table 1-1. Location of all internal adjustments and assemblies is shown in Figure 5-2, and recommended test equipment is listed in Table 5-1.

5-22. PRELIMINARY SET-UP.

5-23. Lock the plug-ins together as shown in Figure 2-1 and install in a HP Model 10407A Plug-in Extender. Insert the 10407A into the Model 180-Series mainframe.

5-24. INITIAL CONTROL SETTINGS.

a. Model 180-Series Oscilloscope:

HORIZONTAL DISPLAY	INT
HORIZONTAL MAGNIFIER	X1
INTENSITY	fully ccw

b. Time Base plug-in:

Sweep Time	1 MSEC
SWEEP MODE	AUTO
Trigger Source	INT

c. Model 1802A Dual Channel Vertical Amplifier:

POSITION A & B	mid-range
A VOLTS/DIV	10 mV
DISPLAY	A
A Polarity	+UP
CAL	fully cw
SYNC SOURCE	NORM

d. Apply power and allow a fifteen minute warm-up. Adjust FOCUS and INTENSITY for a useable display.

5-25. POSITION BALANCE.

a. Monitor the voltage differentially across the collector leads of A4Q21 and A4Q22 using an HP Model 414A Voltmeter.

b. Adjust Channel A DC balance pot A3R42 for a reading of 100 mV or less.

c. Repeat steps a and b for Channel B using DC balance pot A3R6.

5-26. DC LEVEL.

a. Using the HP 414A Voltmeter, adjust the voltage at the collectors of A4Q2 and A4Q3 to -2.8 volts with potentiometer A4R10.

b. Repeat the above step for Channel B using potentiometer A4R36 and measuring voltage at the collectors of A4Q7 and A4Q8.

5-27. SYNC BALANCE.

a. Set controls as follows:

DISPLAY	A
POSITION	centered

b. Connect the HP 414A Voltmeter differentially across the collectors of A3Q6A and A3Q6B.

c. Adjust DC LEVEL potentiometer A3R64 for a reading of 2.5 volts.

d. Measure the voltage at the collector of A3Q17 and adjust Channel A Sync Balance pot, A3R66, for ±50 mV.

e. Repeat steps b through d for Channel B except use Channel B Sync Balance pot A3R30 and measure voltage across A3Q2A/Q2B.

f. Set both traces to center screen using position controls.

g. Switch DISPLAY to A and B.

h. Adjust A3R76 to center the trace.

i. Reinstall plug-ins into mainframe without extender.

5-28. SYNC AMPLIFIER PULSE RESPONSE.

a. Set controls as follows:

DISPLAY	A
A Polarity	+UP
A VOLTS/DIV	.01
SYNC SOURCE	NORM
Sweep Time	.1 MSEC

b. Apply the output from ET 2266 Pulser to the Channel A INPUT.

c. Adjust amplitude to obtain a 4 div vertical display.

d. Connect a cable and 50-ohm load from the Vertical Output jack to the input of a 140-Series sampling scope.

e. Adjust monitor scope to display 10 div vertical deflection and sweep speed to 50 nsec/div.

f. Adjust A3C38 and A3R110 for optimum long time constants displayed.

g. Set Sampling Oscilloscope sweep speed to 10 nsec/div.

h. Make the adjustments given in Table 5-5 to obtain optimum pulse response and risetime.

Table 5-5. A3 Pulse Response

Channel	Adjust
A	A3C23, A3C35, A3C39
B	A3C17, A3C5, A3C39

i. Repeat steps a through d for Channel B and make adjustments shown in Table 5-5.

j. Observe a pulse with less than 3.5 nsec risetime.

5-29. MAIN AMPLIFIER PULSE RESPONSE.

a. Set controls as follows:

DISPLAY	A
SYNC SOURCE	NORM
CAL	fully cw
A Polarity	+
A VOLTS/DIV	.01
Sweep Time	.5 μsec

b. Connect the output of ET 2266 to Channel A INPUT and adjust for 6 div of deflection centered on CRT.

c. Make the adjustments specified in Table 5-6.

Table 5-6. A4 Pulse Response

Step	Adjust	Time Constant
A	R67	Baseline
B	C212	long
C	C2	centered
	R18	medium (ringing)
D	C35	fast
E	C36	centered
	R71	medium
F	C38	centered
	R79	long
G	R42	minimum
	C18	medium

d. Repeat the above adjustments to obtain optimum risetime and pulse response.

e. Repeat steps A through C in Table 5-6 for Channel B using C11 for step B and C7 and R16 for step C.

f. Repeat step A through D for both channels with INPUT set to all other attenuator ranges.

g. Observe a pulse with a risetime of less than 3.5 nanoseconds. Overshoot, undershoot, hook and ringing may not exceed ±3%.

h. Switch DISPLAY to A + B. Observe the risetime for each channel separately. Risetime should be the same as specified in step g above.

5-30. MAIN AMPLIFIER BANDWIDTH.

a. Set controls as follows:

Model 8601A Generator/Sweeper:

SWEEP . . . . . VIDEO
RANGE 110
FREQUENCY . . . . . 100 MHz
TRIG . . . . . FREE RUN
SWEEP MODE . . . . . FAST
LEVEL 1V
1 kHz MOD . . . . . OFF
CRYSTAL . . . . . OFF

Model 180-Series Oscilloscope:

DISPLAY . . . . . EXT

Model 1802A Dual Channel Vertical Amplifier:

DISPLAY . . . . . A
A Polarity . . . . . +UP
A VOLTS/DIV 01V

b. Connect the sweep output of the 8601A to the EXT INPUT on the 180-Series mainframe.

c. Connect the RF output of the 8601A to a 10 dB pad with a 50-ohm cable. Attach the 10 dB pad to the Channel A INPUT of the Model 1802A.

d. Adjust DISPLAY control on 180-Series Oscilloscope mainframe for a sweep starting at the left graticule line and ending at the right hand graticule line.

e. Adjust 8601A Vernier to display an 8 division vertical signal at the beginning of the sweep.

f. Observe a vertical display of greater than 5.6 divisions at the end of the sweep.

g. Repeat steps b through f for Channel B.

PERFORMANCE CHECK RECORD

Paragraph	Check	Min	Reading	Max
5-12	Gain			
step e	.01	-3%	_____	+3%
"	.02	-3%	_____	+3%
"	.05	-3%	_____	+3%
"	.1	-3%	_____	+3%
"	.2	-3%	_____	+3%
"	.5	-3%	_____	+3%
"	1	-3%	_____	+3%
5-13	Vernier			
step d	A	None	_____	2.5:1
"	B	None	_____	2.5:1
5-15	Common Mode Rejection			
step e	A	None	_____	.4 minor div
"	B	None	_____	.4 minor div
step i	A	None	_____	3 minor div
"	B	None	_____	3 minor div
5-16	Crosstalk			
step c	10 kHz	None	_____	1 minor div
"	50 kHz	None	_____	1 minor div
"	100 kHz	None	_____	1 minor div
"	1 MHz	None	_____	1 minor div
"	10 MHz	None	_____	1 minor div
5-18				
step e	A	None	_____	3.5 minor div
"	B	None	_____	3.5 minor div
5-19				
step f	A	5.6 div	_____	None
"	B	5.6 div	_____	None

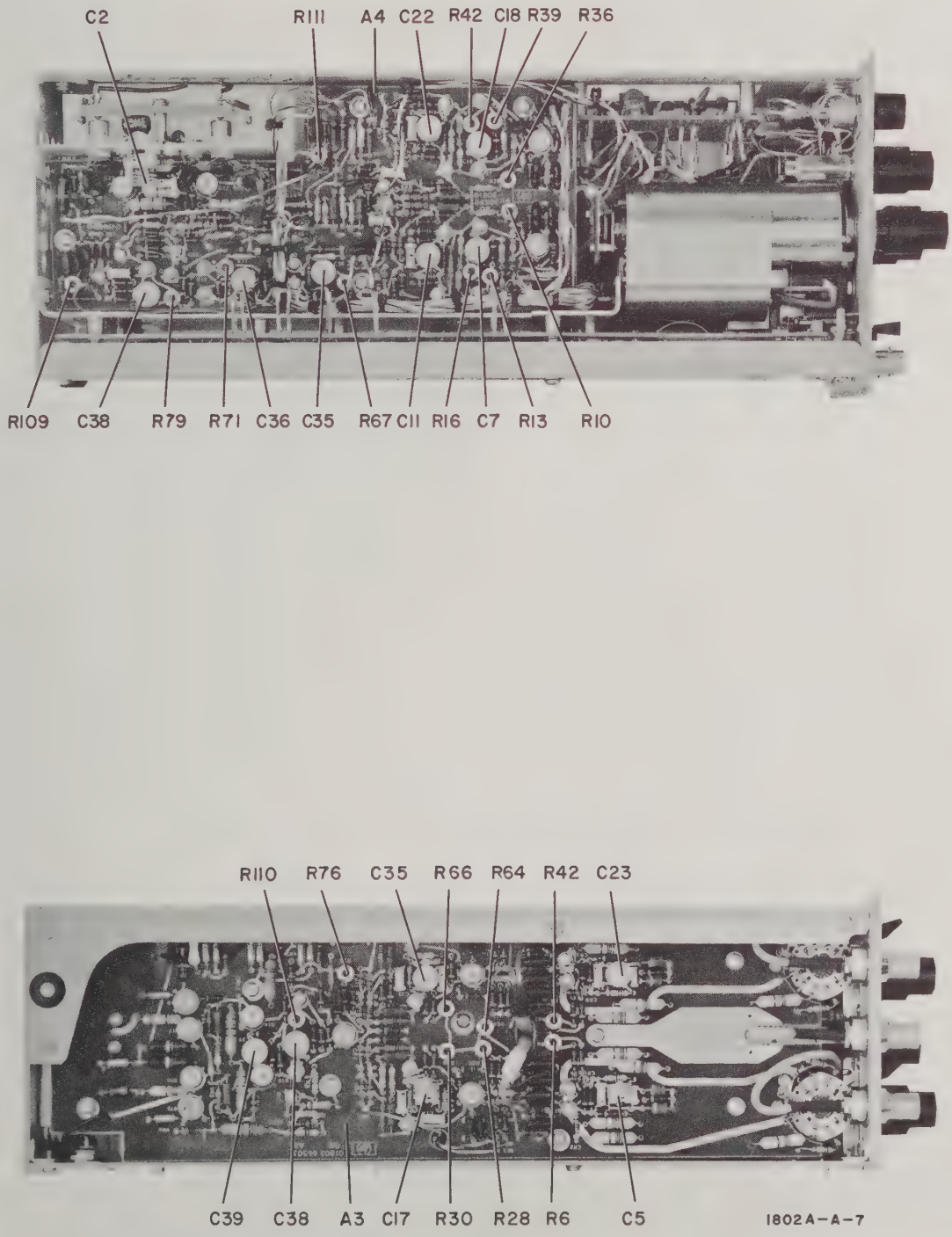


Figure 5-1. Adjustment Location

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replaceable parts for the instrument. Table 6-2 lists the parts in alpha-numerical order of their reference designations and provides the following information for each item:

a. HP Part Number.

b. Total quantity (TQ) used in instrument; given only first time a part number is listed.

c. Description of part; see Table 6-1 for list of reference designators and abbreviations.

6-3. Parts not identified by a reference designation are listed in Table 6-2 under miscellaneous.

6-4. ORDERING INFORMATION.

6-5. To order replacement parts from Hewlett-Packard Company, address the order or inquiry to the nearest HP Sales/Service Office (list at rear of manual) and supply the following information:

a. HP Part Number of item(s).

b. Model number and eight-digit serial number of instrument.

c. Quantity of parts required.

6-6. To order a part not listed in the table, provide the following information:

a. Model number and eight-digit serial number of instrument.

b. Description of part including function and location.

6-7. Component descriptions given in Table 6-2 are as complete as possible to assist in obtaining replacement parts from manufacturers other than HP. However, many parts are manufactured only by HP, or are produced by other manufacturers to HP proprietary specifications, and are therefore available only from HP. Actual manufacturer and manufacturers part number for non-HP parts will be supplied upon request. Contact the nearest HP Sales/Service Office.

Table 6-1. Reference Designators And Abbreviations

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	M	= meter	TB	= terminal board
B	= motor	FL	= filter	MP	= mechanical part	TP	= test point
C	= capacitor	H	= hardware	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
CP	= coupling	IC	= integrated circuit	Q	= transistor		
CR	= diode	J	= jack	R	= resistor	VR	= voltage regulator (diode)
DL	= delay line	K	= relay	RT	= thermistor	W	= cable
DS	= device signaling (lamp)	L	= inductor	S	= switch	X	= socket
E	= misc. electronic part	LS	= speaker	T	= transformer	Y	= crystal

ABBREVIATIONS

amp	= amperes	gl	= glass	mtg	= mounting	rf	= radio frequency
ampl	= amplifier	grd	= ground(ed)	my	= mylar		
		h	= henries	n	= nano (10^{-9})	s-b	= slow-blow
bp	= bandpass	Hg	= mercury	n/c	= normally closed	Se	= selenium
		hr	= hour(s)	ne	= neon	sect	= section(s)
car	= carbon	HP	= Hewlett-Packard	n/o	= normally open	semicon	= semiconductor
ccw	= counterclockwise			npo	= negative positive zero (zero temperature coefficient)	Si	= silicon
cer	= ceramic	if	= intermediate freq.			sil	= silver
coef	= coefficient	impg	= impregnated			sl	= slide
com	= common	incd	= incandescent	nsr	= not separately replaceable	spl	= special
comp	= composition	incl	= include(s)			Ta	= tantalum
conn	= connector	ins	= insulation(ed)			td	= time delay
crt	= cathode-ray tube	int	= internal	obd	= order by description	tgl	= toggle
cw	= clockwise			ox	= oxide	Ti	= titanium
		k	= kilo (10^{3})			tol	= tolerance
depc	= deposited carbon			pc	= printed circuit	trim	= trimmer
		lin	= linear taper	pF	= picofarads = 10^{-12} farads		
elect	= electrolytic	log	= logarithmic taper				
encap	= encapsulated	lpf	= low pass filter	piv	= peak inverse voltage	u	= micro (10^{-6})
ext	= external			p/o	= part of		
		m	= milli (10^{-3})	porc	= porcelain	var	= variable
f	= farads	meg	= mega (10^{6})	pos	= position(s)		
fet	= field effect transistor	metflm	= metal film	pot	= potentiometer	w	= watts
		met ox	= metal oxide	pk-pk	= peak-to-peak	w	= with
fxd	= fixed	mfr	= manufacturer			w o	= without
		minat	= miniature			wvdc	= dc working volts
Ge	= germanium	mom	= momentary	rect	= rectifier	ww	= wirewound

Table 6-2. Replaceable Parts

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS PARTS
A1	01802-63401	1	A: channel A attenuator
A2	01802-63402	1	A: channel B attenuator
A3	01802-66503	1	A: sync amplifier
A4	01802-66501	1	A: vertical amplifier
A5	01802-66502	1	A: channel switching
A6	01802-66501	1	A: vertical output adjust
C1	0160-2150	1	C: fxd mica 33 pF 5% 300V
C2	0121-0128	1	C: var cer 1.4-9.2 pF
C3	0160-0162	1	C: fxd mylar .022 μf 10% 200V
C4	0160-0298	1	C: fxd mylar 1500 pF 10% 200V
CR1	1901-0040	39	CR: si
CR2	1901-0040		CR: si
DL1	01802-62301	1	DL: delay line 162 ns
DS1	5060-0451	2	DS: uncal
DS2	5060-0451		DS: uncal
J1	1250-0252	3	J: female BNC connector
J2	1250-0252		J: female BNC connector
J3	5060-2089	2	J: 3 pin probe power connector
J4	0467-2089		J: 3 pin probe power connector
J5	1250-0252		J: female BNC connector
J6	1250-0897	1	J: RF 75 ohms connector
L1	9100-2255	2	L: fxd .47 μh 10%
L2	9100-2255		L: fxd .47 μh 10%
MP1	01802-00201	1	MP: Front Panel
MP2	01802-00202	1	MP: Sub Panel
MP3	01802-00203	1	MP: Rear Panel
MP4	01802-01201	1	MP: Bracket, sync amp board
MP5	01802-01202	1	MP: Bracket, vertical board
MP6	01802-04701	1	MP: Support, plug-in
MP7	01802-60101	1	MP: Chassis assy, left
MP8	01802-02302	1	MP: Keeper, delay line
MP9	01802-25601	1	MP: Form, delay line
MP10	01802-02301	1	MP: Keeper, transistor
MP11	01802-67401	2	MP: Knob assembly, attenuator
MP12	01802-67402	1	MP: Knob assembly, display
MP13	01802-67403	1	MP: Knob assembly, trigger
MP14	01802-67404	2	MP: Knob assembly, calibrate
MP15	00180-67402	2	MP: Knob assembly, black arrow
MP16	0370-0432	2	MP: Knob, lever
MP17	01802-61201	1	MP: Assy: vert bracket
Q1	1854-0359	2	Q: si npn
Q2	1854-0359		Q: si npn
R1	0757-0454	2	R: fxd metflm 33.2k ohms 1% 1/8w
R2	0698-5965	6	R: fxd metflm 50 ohms 1% 1/2w
R3	0698-5068	6	R: fxd metflm 50 ohms 1% 1/8w
R4	0698-5068		R: fxd metflm 50 ohms 1% 1/8w
R5	0757-0454		R: fxd metflm 33.2k ohms 1% 1/8w
R6	0698-5965		R: fxd metflm 50 ohms 1% 1/2w
R7	0698-5068		R: fxd metflm 50 ohms 1% 1/8w
R8	0698-5068		R: fxd metflm 50 ohms 1% 1/8w
R9	2100-2146	2	R: var comp lin 10k ohms 10% 3/4w
R10	2100-2146		R: var comp lin 10k ohms 10% 3/4w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS PARTS (Cont'd.)
R11	2100-1520	1	R: var comp lin 250 ohms 10% 1/2w
R12	0757-0384	1	R: fxd metflm 20 ohms 1% 1/8w
R13	0757-0400	5	R: fxd metflm 90.9 ohms 1% 1/8w
R14	0757-0400		R: fxd metflm 90.9 ohms 1% 1/8w
R15	0760-0024	4	R: fxd metox 100 ohms 5% 1w
R16	0698-3633	2	R: fxd metox 390 ohms 5% 2w
R17	0698-3633		R: fxd metox 390 ohms 5% 2w
R18	2100-2060	2	R: var cer metflm 50 ohms 30% 1/2w
R19	0757-0419	5	R: fxd metflm 681 ohms 1% 1/8w
R20	0811-2548	2	R: fxd ww 750 ohms 1% 7w
R21	0811-2548		R: fxd ww 750 ohms 1% 7w
R22	0698-3445	2	R: fxd metflm 348 ohms 1% 1/8w
R23	0698-3445		R: fxd metflm 348 ohms 1% 1/8w
R24	0698-3243	1	R: fxd metflm 178k ohms 1% 1/8w
R25	0757-0470	1	R: fxd metflm 162k ohms 1% 1/8w
R26	0757-0911	11	R: fxd metflm 300 ohms 2% 1/4w
R27	0757-0442	2	R: fxd metflm 10k ohms 1% 1/8w
R28	0757-0442		R: fxd metflm 10k ohms 1% 1/8w
S1	3100-1387	2	S: polarity
S2	3100-1387		S: polarity
S3	3100-1386	1	S: display
P1	01801-27601	1	P: 24 pin connector
W1	01802-61601	1	W: cable assy, main
W2	01802-61605	1	W: cable assy: sync vertical channel A
W3	01802-61606	1	W: cable assy: sync vertical channel B
A1	01802-63401		A: channel A attenuator
R1	0698-6790		R: fxd metflm 150 ohms 0.5% 1/4w
R2	0698-6792		R: fxd metflm 37.5 ohms 0.5% 1/4w
R3	0698-6790		R: fxd metflm 150 ohms 0.5% 1/4w
R4	0698-6789		R: fxd metflm 75 ohms 0.5% 1/2w
R5	0698-6791		R: fxd metflm 120 ohms 0.5% 1/4w
R6	0698-6795		R: fxd metflm 75 ohms 0.5% 1/4w
R7	0698-6794		R: fxd metflm 61.1 ohms 0.5% 1/8w
R8	0698-6793		R: fxd metflm 248 ohms 0.5% 1/8w
R9	0698-6794		R: fxd metflm 61.1 ohms 0.5% 1/8w
R10	0698-5965		R: fxd metflm 50 ohms 1% 1/2w
R11	0698-5965		R: fxd metflm 50 ohms 1% 1/2w
R12	2100-2687	4	R: var car comp 1000 ohms 10% 1/2w
R13	2100-2687		R: var car comp 1000 ohms 10% 1/2w
S1	3100-1385		S: attenuator
S2	3100-2503		S: uncal
A2	01802-63402		A: channel B attenuator
R1	0698-6790		R: fxd metflm 150 ohms 0.5% 1/4w
R2	0698-6792		R: fxd metflm 37.5 ohms 0.5% 1/4w
R3	0698-6790		R: fxd metflm 150 ohms 0.5% 1/4w
R4	0698-6789		R: fxd metflm 75 ohms 0.5% 1/2w
R5	0698-6791		R: fxd metflm 120 ohms 0.5% 1/4w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A2 (Cont'd.)			
R6	0698-6795		R: fxd metflm 75 ohms 0.5% 1/4w
R7	0698-6794		R: fxd metflm 61.1 ohms 0.5% 1/8w
R8	0698-6793		R: fxd metflm 248 ohms 0.5% 1/8w
R9	0698-6794		R: fxd metflm 61.1 ohms 0.5% 1/8w
R10	0698-5965		R: fxd metflm 50 ohms 1% 1/2w
R11	0698-5965		R: fxd metflm 50 ohms 1% 1/2w
R12	2100-2687		R: var car comp 1000 ohms 10% 1/2w
R13	2100-2687		R: var car comp 1000 ohms 10% 1/2w
S1	3100-1385		S: attenuator
S2	3100-2503		S: uncal
A3	01802-66503		A: sync amplifier
C1	0150-0011	4	C: fxd titanium dioxide 1.5 pF 20% 500V
C2	0150-0011		C: fxd titanium dioxide 1.5 pF 20% 500V
C3	0140-0228	8	C: fxd mica 360 pF 1%
C4	0140-0228		C: fxd mica 360 pF 1%
C5	0121-0036	2	C: var cer 5.5-18 pF
C6	0160-2251	4	C: fxd cer 5.6 pF 10% 500V
C7	0160-3051	2	C: fxd cer 14.8 pF 10% 500V
C8	0140-0228		C: fxd mica 360 pF 1%
C9	0140-0228		C: fxd mica 360 pF 1%
C10	0160-2905	31	C: fxd cer 1000 pF -20 +100% 500V
C11	0160-2905		C: fxd cer 1000 pF -20 +100% 500V
C12	0160-2905		C: fxd cer 1000 pF -20 +100% 500V
C13	0160-2905		C: fxd cer 1000 pF -20 +100% 500V
C14	0160-0153	12	C: fxd mylar 1000 pF 10% 500V
C15	0160-0153		C: fxd mylar 1000 pF 10% 500V
C16	0160-2251		C: fxd cer 5.6 pF 500V
C17	0121-0036		C: var cer 5.5-18 pF
C18	0160-2249	2	C: fxd cer 4.7 pF 500V
C19	0150-0011		C: fxd titanium dioxide 1.5 pF 20% 500V
C20	0150-0011		C: fxd titanium dioxide 1.5 pF 20% 500V
C21	0140-0228		C: fxd mica 360 pF 1%
C22	0140-0228		C: fxd mica 360 pF 1%
C23	0121-0061	10	C: var cer 5.5-18 pF
C24	0160-2251		C: fxd cer 5.6 pF 500V
C25	0160-3051		C: fxd cer 14.8 pF 10% 500V
C26	0140-0228		C: fxd mica 360 pF 1%
C27	0140-0228		C: fxd mica 360 pF 1%
C28	0160-2905		C: fxd cer 1000 pF 500V
C29	0160-2905		C: fxd cer 1000 pF 500V
C30	0160-2905		C: fxd cer 1000 pF 500V
C31	0160-2905		C: fxd cer 1000 pF 500V
C32	0160-0153		C: fxd mylar 1000 pF 10% 500V
C33	0160-0153		C: fxd mylar 1000 pF 10% 500V
C34	0160-2251		C: fxd cer 5.6 pF 500V
C35	0121-0061		C: var cer 5.5-18 pF
C36	0160-2249		C: fxd cer 4.7 pF 500V
C37	0160-2905		C: fxd cer 1000 pF 500V
C38	0121-0061		C: var cer 5.5-18 pF
C39	0121-0061		C: var cer 5.5-18 pF
C40	0160-0153		C: fxd mylar 1000 pF 10% 500V

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A3 (Cont'd.)			
C41	0160-0153		C: fxd mylar 1000 pF
C42 thru C51	0180-0291	18	C: fxd ta 1 μf 10% 35V
C52	0160-2905		C: fxd cer 1000 pF 500V
CR1 thru CR15	1901-0040		CR: si
L1 thru L3	9140-0047	19	L: fxd 20 μh 10%
L4	9140-0094	1	L: fxd .68 μh 15%
L5 thru L9	9140-0047		L: fxd 20 μh 10%
Q1	1854-0357	2	Q: si npn dual
Q2	1853-0207	4	Q: si pnp dual
Q3	1854-0345	8	Q: si npn
Q4	1854-0345		Q: si npn
Q5	1854-0357		Q: si npn dual
Q6	1853-0207		Q: si pnp dual
Q7	1854-0345		Q: si npn
Q8	1854-0345		Q: si npn
Q9	1853-0075	1	Q: si pnp dual
Q10	1853-0026	4	Q: si pnp
Q11	1853-0026		Q: si pnp
Q12	1853-0010	1	Q: si pnp
Q13	1854-0344	4	Q: si npn
Q14	1854-0344		Q: si npn
Q15 thru Q18	1854-0091	4	Q: si npn
R1 thru R4	0757-0198	10	R: fxd metflm 100 ohms 1% 1/2w
R5	0757-0927	8	R: fxd metflm 1300 ohms 2% 1/4w
R6	2100-1788	5	R: var cer metflm 500 ohms 30% 1/2w
R7	0757-0927		R: fxd metflm 1300 ohms 2% 1/4w
R8	0757-0904	6	R: fxd metflm 150 ohms 2% 1/4w
R9	0757-0894	2	R: fxd metflm 56 ohms 2% 1/4w
R10	0757-0904		R: fxd metflm 150 ohms 2% 1/4w
R11	0757-0926	8	R: fxd metflm 1200 ohms 2% 1/4w
R12	0757-0926		R: fxd metflm 1200 ohms 2% 1/4w
R13	0757-0394	2	R: fxd metflm 51.1 ohms 1% 1/8w
R14	0757-0903	4	R: fxd metflm 130 ohms 2% 1/4w
R15	0757-0926		R: fxd metflm 1200 ohms 2% 1/4w
R16	0757-0926		R: fxd metflm 1200 ohms 2% 1/4w
R17	0757-0392	8	R: fxd metflm 43.2 ohms 1% 1/8w
R18	0757-0392		R: fxd metflm 43.2 ohms 1% 1/8w
R19	0757-0917	8	R: fxd metflm 510 ohms 2% 1/4w
R20	0757-0917		R: fxd metflm 510 ohms 2% 1/4w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A3 (Cont'd.)			
R21	0757-0928	2	R: fxd metflm 1500 ohms 2% 1/4w
R22	0757-0941	10	R: fxd metflm 5100 ohms 2% 1/4w
R23	0757-0941		R: fxd metflm 5100 ohms 2% 1/4w
R24	0757-0900	12	R: fxd metflm 100 ohms 2% 1/4w
R25	0757-0920	10	R: fxd metflm 680 ohms 2% 1/4w
R26	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R27	0757-0914	4	R: fxd metflm 390 ohms 2% 1/4w
R28	2100-2061	4	R: var cer metflm 200 ohms 30% 1/2w
R29	0757-0927	6	R: fxd metflm 1300 ohms 2% 1/4w
R30	2100-1788		R: var cer metflm 500 ohms 30% 1/2w
R31	0757-0927		R: fxd metflm 1300 ohms 2% 1/4w
R32	0757-0912	2	R: fxd metflm 330 ohms 2% 1/4w
R33	0757-0402	4	R: fxd metflm 110 ohms 1% 1/8w
R34	0757-0402		R: fxd metflm 110 ohms 1% 1/8w
R35	0698-3430		R: fxd metflm 21.5 ohms 1% 1/8w
R36	0757-0944	2	R: fxd metflm 6800 ohms 2% 1/4w
R37 thru R40	0757-0198		R: fxd metflm 100 ohms 1% 1/2w
R41	0757-0927		R: fxd metflm 1300 ohms 2% 1/4w
R42	2100-1788		R: var cer metflm 500 ohms 30% 1/2w
R43	0757-0927		R: fxd metflm 1300 ohms 2% 1/4w
R44	0757-0904		R: fxd metflm 150 ohms 2% 1/4w
R45	0757-0926		R: fxd metflm 1200 ohms 2% 1/4w
R46	0757-0926		R: fxd metflm 1200 ohms 2% 1/4w
R47	0757-0894		R: fxd metflm 56 ohms 2% 1/4w
R48	0757-0904		R: fxd metflm 150 ohms 2% 1/4w
R49	0757-0394		R: fxd metflm 51.1 ohms 1% 1/8w
R50	0757-0903		R: fxd metflm 130 ohms 2% 1/4w
R51	0757-0926		R: fxd metflm 1200 ohms 2% 1/4w
R52	0757-0926		R: fxd metflm 1200 ohms 2% 1/4w
R53	0757-0392		R: fxd metflm 43.2 ohms 1% 1/8w
R54	0757-0392		R: fxd metflm 43.2 ohms 1% 1/8w
R55	0757-0917		R: fxd metflm 510 ohms 2% 1/4w
R56	0757-0917		R: fxd metflm 510 ohms 2% 1/4w
R57	0757-0928		R: fxd metflm 1500 ohms 2% 1/4w
R58	0757-0941		R: fxd metflm 5100 ohms 2% 1/4w
R59	0757-0941		R: fxd metflm 5100 ohms 2% 1/4w
R60	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R61	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R62	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R63	0757-0914		R: fxd metflm 390 ohms 2% 1/4w
R64	2100-2061		R: var cer metflm 200 ohms 30% 1/2w
R65	0757-0927		R: fxd metflm 1300 ohms 2% 1/4w
R66	2100-1788		R: var cer metflm 500 ohms 30% 1/2w
R67	0757-0927		R: fxd metflm 1300 ohms 2% 1/4w
R68	0757-0912		R: fxd metflm 330 ohms 2% 1/4w
R69	0757-0402		R: fxd metflm 110 ohms 1% 1/8w
R70	0757-0402		R: fxd metflm 110 ohms 1% 1/8w
R71	0698-3430		R: fxd metflm 21.5 ohms 1% 1/8w
R72	0757-0944		R: fxd metflm 6800 ohms 2% 1/4w
R73	0757-0915	2	R: fxd metflm 430 ohms 2% 1/4w
R74	0757-0915		R: fxd metflm 430 ohms 2% 1/4w
R75	0757-0921		R: fxd metflm 250 ohms 2% 1/4w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A3 (Cont'd.)			
R76	2100-1788		R: var cer metflm 500 ohms 30% 1/2w
R77	0757-0921		R: fxd metflm 750 ohms 2% 1/4w
R78	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R79	0757-0273		R: fxd metflm 3.01k ohms 1% 1/8w
R80	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R81	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R82	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R83	0757-0904		R: fxd metflm 150 ohms 2% 1/4w
R84	0757-0904		R: fxd metflm 150 ohms 2% 1/4w
R85	0698-3397		R: fxd metflm 42.2 ohms 1% 1/2w
R86	0757-0911	10	R: fxd metflm 300 ohms 2% 1/4w
R87	0757-0911		R: fxd metflm 300 ohms 2% 1/4w
R88	0757-0902		R: fxd metflm 120 ohms 2% 1/4w
R89	0757-0902		R: fxd metflm 120 ohms 2% 1/4w
R90	0757-0803		R: fxd metflm 182 ohms 1% 1/2w
R91	0757-0806	3	R: fxd metflm 243 ohms 1% 1/2w
R92	0757-0806		R: fxd metflm 243 ohms 1% 1/2w
R93	0757-0907		R: fxd metflm 200 ohms 2% 1/4w
R94	0757-0907		R: fxd metflm 200 ohms 2% 1/4w
R95	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R96	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R97	0760-0024		R: fxd metox 100 ohms 5% 1w
R98	0760-0024		R: fxd metox 100 ohms 5% 1w
R99	0757-0178	1	R: fxd metflm 100 ohms 1% 1/4w
R100	0757-0704	1	R: fxd metflm 43.2 ohms 1% 1/4w
R101	0760-0024	1	R: fxd metox 100 ohms 5% 1w
R102	0757-0408	2	R: fxd metflm 243 ohms 1% 1/8w
R103	0698-3150	1	R: fxd metflm 2.37k ohms 1% 1/8w
R104	0757-0420	1	R: fxd metflm 750 ohms 1% 1/8w
R105	0757-0284	1	R: fxd metflm 150 ohms 1% 1/8w
R106 thru R109	0757-0893		R: fxd metflm 51 ohms 2% 1/4w
R110	2100-2061		R: var cer metflm 200 ohms 30% 1/2w
VR1	1902-0045	2	VR: breakdown 7.32V 2%
VR2	1902-0045		VR: breakdown 7.32V 2%
VR3	1902-3094	2	VR: breakdown 5.11V 2%
VR4	1902-3110		VR: breakdown 5.9V 2%
VR5	1902-3137		VR: breakdown 8.1V 2%
VR6	1902-3137		VR: breakdown 8.1V 2%
A4	01802-66501		A: vertical amplifier
C1 thru C3	0160-2905		C: fxd cer 1000 pF 20% 500V
C4	0160-2197	4	C: fxd mica 10 pF 5% 300V
C5	0160-2197		C: fxd mica 10 pF 5% 300V
C6	0160-2905		C: fxd cer 1000 pF 20% 500V
C7	0121-0061		C: var cer 5.5-18 pF
C8	0160-0153		C: fxd mylar 1000 pF 10%
C9	0160-0153		C: fxd mylar 1000 pF 10%
C10	0160-2264	2	C: fxd cer 20 pF 5% 500V

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A4 (Cont'd.)			
C11	0121-0061		C: var cer 5.5-18 pF
C12 thru C14	0160-2905		C: fxd cer 1000 pF 20% 500V
C15	0160-2197		C: fxd mica 10 pF 5% 300V
C16	0160-2197		C: fxd mica 10 pF 5% 300V
C17	0160-2905		C: fxd cer 1000 pF 20% 500V
C18	0121-0061		C: var cer 5.5-18 pF
C19	0160-0153		C: fxd mylar 1000 pF 10%
C20	0160-0153		C: fxd mylar 1000 pF 10%
C21	0160-2264		C: fxd cer 20 pF 5% 500V
C22	0121-0061		C: var cer 5.5-18 pF
C23	0160-2256	2	C: fxd cer 9.1 pF .25% 500V
C24	0160-2256		C: fxd cer 9.1 pF .25% 500V
C25	0160-2905		C: fxd cer 1000 pF 20% 500V
C26	0160-0153		C: fxd mylar 1000 pF 10% 500V
C27	0160-0153		C: fxd mylar 1000 pF 10% 500V
C28	0160-2905		C: fxd cer 1000 pF 20% 500V
C29	0160-2905		C: fxd cer 1000 pF 20% 500V
C30	0180-0291		C: fxd ta 1 μf 10% 35V
C31	0160-2905		C: fxd cer 1000 pF 20% 500V
C32	0180-0291		C: fxd ta 1 μf 10% 35V
C33	0160-2905		C: fxd cer 1000 pF 20% 500V
C34	0160-2308	1	C: fxd mica 36 pF 5%
C35	0121-0060	1	C: var cer 2-8 pF
C36	0121-0061		C: var cer 5.5-18 pF
C37	0140-0216	3	C: fxd mica 120 pF 2% 300V
C38	0121-0061		C: var cer 5.5-18 pF
C39	0160-2246	1	C: fxd cer 3.6 pF .25% 500V
C40 thru C45	0160-2905		C: fxd cer 1000 pF 20% 500V
C46	0180-0291		C: fxd ta 1 μf 10% 35V
C47 thru C49	0150-0111	4	C: fxd mica 220 pF 5% 300V
C50	0160-2905		C: fxd cer 1000 pF 20% 500V
C51 thru C53	0180-0291		C: fxd ta 1 μf 10% 35V
C54	0150-0111		C: fxd mica 220 pF 5% 300V
C55	0160-2905		C: fxd cer 1000 pF 20% 500V
C56	0160-2249	1	C: fxd cer 4.7 pF .25% 500V
CR1 thru CR10	1901-0040		CR: si
L1 thru L9	9140-0047		L: fxd 20 μh 10%
L10 thru L13	9170-0029	4	L: ferrite beads

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A4 (Cont'd.)			
Q1	1853-0207		Q: si pnp
Q2	1853-0061	6	Q: si pnp
Q3	1853-0061		Q: si pnp
Q4	1854-0345		Q: si npn 2N5179
Q5	1854-0345		Q: si npn 2N5179
Q6	1853-0061		Q: si pnp
Q7	1853-0061		Q: si pnp
Q8	1853-0061		Q: si pnp
Q9	1854-0345		Q: si npn 2N5179
Q10	1854-0345		Q: si npn 2N5179
Q11	1853-0026		Q: si pnp
Q12	1853-0026		Q: si pnp
Q13 thru Q18	1854-0269		Q: si npn
Q19	1853-0061		Q: si pnp
Q20	1853-0061		Q: si pnp
Q21	1854-0344		Q: si npn
Q22	1854-0344		Q: si npn
Q23	1854-0087		Q: si npn
Q24	1854-0087	2	Q: si npn
Q25	1854-0071	5	Q: si npn
Q26	1854-0071		Q: si npn
Q27	1854-0023	1	Q: si npn
R1	0757-0941		R: fxd metflm 5.1k ohms 2% 1/4w
R2	0757-0941		R: fxd metflm 5.1k ohms 2% 1/4w
R3	0757-0392		R: fxd metflm 43.2 ohms 1% 1/8w
R4	0757-0392		R: fxd metflm 43.2 ohms 1% 1/8w
R5	0757-0917		R: fxd metflm 510 ohms 2% 1/4w
R6	0757-0917		R: fxd metflm 510 ohms 2% 1/4w
R7	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R8	0757-0419		R: fxd metflm 681 ohms 1% 1/8w
R9	0757-0914		R: fxd metflm 390 ohms 2% 1/4w
R10	2100-2061		R: var cer metflm 200 ohms 30% 1/2w
R11	0757-0419		R: fxd metflm 681 ohms 1% 1/8w
R12	0757-0911		R: fxd metflm 300 ohms 2% 1/4w
R13	2100-1984	5	R: var cer metflm 100 ohms 30% 1/2w
R14	0757-0922		R: fxd metflm 820 ohms 2% 1/4w
R15	0757-0922		R: fxd metflm 820 ohms 2% 1/4w
R16	2100-1984		
R17	0757-0924	10	R: fxd metflm 1k ohm 2% 1/4w
R18	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R19	0757-0428	2	R: fxd metflm 1.62k ohm 1% 1/8w
R20	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R21	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R22	0757-0906	2	R: fxd metflm 180 ohms 2% 1/4w
R23	0757-0911		R: fxd metflm 200 ohms 2% 1/4w
R24	0757-0911		R: fxd metflm 300 ohms 2% 1/4w
R25	0757-0945	2	R: fxd metflm 7.5k ohms 2% 1/4w
R26	0757-0931		R: fxd metflm 2k ohms 2% 1/4w
R27	0757-0941		R: fxd metflm 5.1k ohms 2% 1/4w
R28	0757-0941		R: fxd metflm 5.1k ohms 2% 1/4w
R29	0757-0392		R: fxd metflm 43.2 ohms 1% 1/8w
R30	0757-0392		R: fxd metflm 43.2 ohms 1% 1/8w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A4 (Cont'd.)			
R31	0757-0917		R: fxd metflm 510 ohms 2% 1/4w
R32	0757-0917		R: fxd metflm 510 ohms 2% 1/4w
R33	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R34	0757-0419		R: fxd metflm 681 ohms 1% 1/8w
R35	0757-0914		R: fxd metflm 390 ohms 2% 1/4w
R36	2100-2061		R: var cer metflm 200 ohms 30% 1/2w
R37	0757-0419		R: fxd metflm 681 ohms 1% 1/8w
R38	0757-0911		R: fxd metflm 300 ohms 2% 1/4w
R39	2100-1984		R: var cer metflm 100 ohms 30% 1/2w
R40	0757-0922		R: fxd metflm 820 ohms 2% 1/4w
R41	0757-0922		R: fxd metflm 820 ohms 2% 1/4w
R42	2100-1984		R: var cer metflm 100 ohms 30% 1/2w
R43	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R44	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R45	0757-0428		R: fxd metflm 1.62k ohm 1% 1/8w
R46	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R47	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R48	0757-0906		R: fxd metflm 180 ohms 2% 1/4w
R49	0757-0911		R: fxd metflm 300 ohms 2% 1/4w
R50	0757-0911		R: fxd metflm 300 ohms 2% 1/4w
R51	0757-0945		R: fxd metflm 7.5k ohms 2% 1/4w
R52	0757-0931		R: fxd metflm 2k ohms 2% 1/4w
R53	0757-0913	2	R: fxd metflm 360 ohms 2% 1/4w
R54	0757-0913		R: fxd metflm 360 ohms 2% 1/4w
R55	0757-0935	1	R: fxd metflm 3k ohms 2% 1/4w
R56	0757-0919	2	R: fxd metflm 620 ohms 2% 1/4w
R57	0757-0919		R: fxd metflm 620 ohms 2% 1/4w
R58	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R59	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R60	0757-0914		R: fxd metflm 390 ohms 2% 1/4w
R61	0757-0914		R: fxd metflm 390 ohms 2% 1/4w
R62	0757-0400		R: fxd metflm 90.9 ohms 1% 1/8w
R63	0757-0400		R: fxd metflm 90.9 ohms 1% 1/8w
R64	0757-0417	2	R: fxd metflm 562 ohms 1% 1/8w
R65	0757-0417		R: fxd metflm 562 ohms 1% 1/8w
R66	0757-0408		R: fxd metflm 243 ohms 1% 1/8w
R67	2100-2031	1	R: var cer metflm 50k ohms 30% 1/2w
R68	0757-0413	2	R: fxd metflm 392 ohms 1% 1/8w
R69	0757-0413		R: fxd metflm 392 ohms 1% 1/8w
R70	0757-0400		R: fxd metflm 90.9 ohms 1% 1/8w
R71	2100-2060	1	R: var cer metflm 50 ohms 30% 1/2w
R72	0757-0915		R: fxd metflm 430 ohms 2% 1/4w
R73	0757-0960	1	R: fxd metflm 33k ohms 2% 1/4w
R74	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R75	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R76	0757-0908	5	R: fxd metflm 220 ohms 2% 1/4w
R77	0757-0908		R: fxd metflm 220 ohms 2% 1/4w
R78	0757-0806		R: fxd metflm 243 ohms 1% 1/2w
R79	2100-1984		R: var cer metflm 100 ohms 30% 1/2w
R80	0757-0952		R: fxd metflm 15k ohms 2% 1/4w
R81	0757-0911		R: fxd metflm 300 ohms 2% 1/4w
R82	0757-0911		R: fxd metflm 300 ohms 2% 1/4w
R83	0757-0941		R: fxd metflm 5.1k ohms 2% 1/4w
R84	0757-0941		R: fxd metflm 5.1k ohms 2% 1/4w
R85	0757-0908		R: fxd metflm 220 ohms 2% 1/4w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A4 (Cont'd.)			
R86	0757-0915		R: fxd metflm 430 ohms 2% 1/4w
R87	0757-0915		R: fxd metflm 430 ohms 2% 1/4w
R88	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R89	0757-0900		R: fxd metflm 100 ohms 2% 1/4w
R90	0757-0936	1	R: fxd metflm 3.3k ohms 2% 1/4w
R91	0757-0928	1	R: fxd metflm 1.5k ohm 2% 1/4w
R92	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R93	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R94	0761-0052	2	R: fxd metox 270 ohms 5% 1w
R95	0761-0052		R: fxd metox 270 ohms 5% 1w
R96	0758-0032	2	R: fxd metflm 820 ohms 5% 1/2w
R97	0758-0032		R: fxd metflm 820 ohms 5% 1/2w
R98	0757-0337		R: fxd metflm 432 ohms 1% 1/4w
R99	0757-0198		R: fxd metflm 100 ohms 1% 1/2w
R100	0757-0198		R: fxd metflm 100 ohms 1% 1/2w
R101	0757-0903		R: fxd metflm 130 ohms 2% 1/4w
R102	0761-0070	2	R: fxd metox 8.2k ohms 5% 1w
R103	0757-0938		R: fxd metflm 3.9k ohms 1% 1/4w
R104	0757-0952		R: fxd metflm 15k ohms 2% 1/4w
R105	0761-0070		R: fxd metox 8.2k ohms 5% 1w
R106	0757-0938		R: fxd metflm 3.9k ohms 2% 1/4w
R107	0757-0952		R: fxd metflm 15k ohms 2% 1/4w
R108	0757-0959		R: fxd metflm 30k ohms 2% 1/4w
R109	2100-2030	2	R: var cer metflm 20k ohms 30% 1/2w
R110	0757-0959		R: fxd metflm 30k ohms 2% 1/4w
R111	0757-0903		R: fxd metflm 130 ohms 2% 1/4w
R112	0757-0903		R: fxd metflm 130 ohms 2% 1/4w
R113	0698-6994	4	R: fxd metflm 30 ohms 2% 1/4w
R114	0698-6994		R: fxd metflm 30 ohms 2% 1/4w
R115	0698-6994		R: fxd metflm 30 ohms 2% 1/4w
R116	0698-6994		R: fxd metflm 30 ohms 2% 1/4w
VR1	1902-3094		VR: breakdown 5.11V 2%
VR2	1902-3097	1	VR: breakdown 5.23V 2%
VR3	1902-0799	1	VR: breakdown 7.5V 5%
A5	01802-66502		A: channel switching
C1	0150-0093	5	C: fxd cer .01 μf -20 +80% 100V
C2	0160-2204	2	C: fxd mica 100 pF 5% 300V
C3	0160-2204		C: fxd mica 100 pF 5% 300V
C4	0150-0093		C: fxd cer .01 μf -20 +80% 100V
C5	0150-0093		C: fxd cer .01 μf -20 +80% 100V
C6	0150-0093		C: fxd cer .01 μf -20 +80% 100V
C7	0140-0216		C: fxd mica 120 pF 2% 300V
C8	0140-0216		C: fxd mica 120 pF 2% 300V
C9	0150-0093		C: fxd cer .01 μf -20 +80% 100V
C10	0180-0291		C: fxd ta 1 μf 10% 35V
C11	0180-0291		C: fxd ta 1 μf 10% 35V
CR1 thru CR12	1901-0040		CR: si
L1	9140-0142	1	L: fxd 2.2 μh 10%
L2	9140-0047		L: fxd 20 μh 10%
L3	9140-0047		L: fxd 20 μh 10%

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A5 (Cont'd.)			
Q1	1853-0015	2	Q: si pnp
Q2	1853-0015		Q: si pnp
Q3	1854-0071		Q: si npn
Q4	1854-0071		Q: si npn
Q5	1853-0007	2	Q: si pnp
Q6	1853-0007		Q: si pnp
Q7	1854-0071		Q: si npn
Q8	1853-0036	1	Q: si pnp
R1	0757-0915		R: fxd metflm 430 ohms 2% 1/4w
R2	0757-0421	2	R: fxd metflm 825 ohms 1% 1/8w
R3	0757-0421		R: fxd metflm 825 ohms 1% 1/8w
R4	0757-0438		R: fxd metflm 5.11k ohms 1% 1/8w
R5	0757-0438		R: fxd metflm 5.11k ohms 1% 1/8w
R6	0757-0288	4	R: fxd metflm 9.09k ohms 1% 1/8w
R7	0757-0288		R: fxd metflm 9,09k ohms 1% 1/8w
R8	0757-0920		R: fxd metflm 680 ohms 2% 1/4w
R9	0757-0427		R: fxd metflm 1.5k ohms 1% 1/8w
R10	0757-0444		R: fxd metflm 12.1k ohms 1% 1/8w
R11	0757-0461	2	R: fxd metflm 68.1k ohms 1% 1/8w
R12	0757-0461		R: fxd metflm 68.1k ohms 1% 1/8w
R13	0757-0288		R: fxd metflm 9.09k ohms 1% 1/8w
R14	0757-0288		R: fxd metflm 9.09k ohms 1% 1/8w
R15	0757-0729		R: fxd metflm 681 ohms 1% 1/4w
R16	0757-0936		R: fxd metflm 3.3k ohms 2% 1/4w
R17	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R18	0757-0924		R: fxd metflm 1k ohm 2% 1/4w
R19	0757-0908		R: fxd metflm 220 ohms 2% 1/4w
R20	0757-0908		R: fxd metflm 220 ohms 2% 1/4w
R21	0757-0914		R: fxd metflm 390 ohms 2% 1/4w
R22	2100-0783	1	R: var ww 200 ohms 5% 1w
R23	0698-6994		R: fxd flm 30 ohms 2% 1/4w
R24	0698-6994		R: fxd flm 30 ohms 2% 1/4w
R25	0761-0048	2	R: fxd metox 160 ohms 5% 1w
R26	0761-0048		R: fxd metox 160 ohms 5% 1w
R27	0757-0931		R: fxd metflm 2k ohms 2% 1/4w
R28	0757-0931		R: fxd metflm 2k ohms 2% 1/4w
R29	0757-0948		R: fxd metflm 10k ohms 2% 1/4w
R30	0757-0948		R: fxd metflm 10k ohms 2% 1/4w
R31	0757-0283		R: fxd metflm 2k ohms 1% 1/8w
R32	0757-0416		R: fxd metflm 511 ohms 1% 1/8w
R33	0757-0427		R: fxd metflm 1.5k ohm 1% 1/8w
R34	0757-0457		R: fxd metflm 47.5k ohms 1% 1/8w
R35	0757-0273		R: fxd metflm 3.01k ohms 1% 1/8w
R36	0757-0446		R: fxd metflm 15k ohms 1% 1/8w
A6			
R1	2100-1831	1	R: var comp 100 ohms 10% 1/2w
R2	0698-5068		R: fxd metflm 50 ohms 1% 1/8w
R3	0698-5068		R: fxd metflm 50 ohms 1% 1/8w

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to standard Model 1802A Dual Channel Vertical Amplifiers having a serial number prefixed by 827- (refer to Paragraph 1-5). The following paragraphs provide instructions for modifying this manual to cover older (lower serial prefix) or newer (higher serial prefix) instruments. Refer to separate "Manual Changes" sheet supplied with this manual for Errata.

7-3. OLDER INSTRUMENTS.

7-4. Table 7-1 contains information on changes required to adapt this manual to an older instrument (lower serial prefix). Check Table 7-1 for your instrument serial prefix and make the changes indicated. Note that these changes adapt the manual to cover a particular instrument as manufactured; and therefore will not apply to an instrument subsequently modified in the field.

7-5. NEW INSTRUMENTS.

7-6. As changes are made to the Model 1802A, newer instruments may have serial prefixes higher than 827-. The manual for these instruments will be supplied with a "Manual Changes" sheet which contains the required updating information. If the change sheet is missing, contact the nearest HP Sales/Service Office.

7-7. OPTIONS.

7-8. Options for an HP instrument are standard modifications to a standard instrument, and are installed at the factory. At present, no options are available for the Model 1802A Dual Channel Vertical Amplifier.

7-9. SPECIAL INSTRUMENTS.

7-10. Modified versions (per customer specifications) of any HP instrument are available on special order. The manual for these special instruments (having electrical modifications), includes a separate insert sheet, which describes the modification and any manual changes required in addition to any "Manual Changes" sheet (refer to Paragraph 7-6). Contact the nearest HP Sales/Service Office if either of these sheets are missing from the manual for a special instrument, being sure to refer to the instrument by its full specification number and name.

Table 7-1. Manual Changes

Instrument Serial Prefix Number	Incorporate change (s) Numbered
No backdating changes are required at the present time.	

SECTION VIII
SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains Model 1802A schematic diagrams, component location pictorials, troubleshooting information and repair and replacement procedures.

8-3. SCHEMATIC DIAGRAMS.

8-4. Schematic diagrams appear on right hand pages that unfold outside the right edge of the manual. These "throw clear" pages allow viewing the schematics while referring to another section. Text can be followed by unfolding the appropriate "throw clear" page.

8-5. Schematics are drawn primarily to show the electronic function of an instrument. A given schematic may include all or part of several assemblies. Schematics also include dc voltages and waveform measurement test points. Waveforms applicable to each schematic are shown opposite that schematic. DC voltage and waveform measurement conditions are shown in Table 8-2. Information about symbols and conventions used in these schematics is provided by Table 8-1.

8-6. COMPONENT IDENTIFICATION.

8-7. Chassis mounted parts, not on an assembly, are shown in Figure 8-3 and 8-13. Assembly mounted components are shown on page opposite the schematic. When an assembly appears on more than one schematic, all components are identified opposite the schematic on which the assembly first appears.

8-8. REFERENCE DESIGNATIONS.

8-9. The unit system of reference designation, used in this manual, is in accordance with the provisions of the American Standard Electrical and Electronics Reference Designations. Minor variations, due to design and manufacturing, may be noted. A brief explanation is presented here for those unfamiliar with the designation system.

8-10. Each component is identified by a letter-number combination. For example R1, R2, - - - C1, C2; etc. This letter-number combination is the basic designation for each component. Components which are separately replaceable and are part of an assembly have, in addition to the basic designator, a prefix designation which identifies the assembly on which the component is located. Components not mounted on an assembly have only the basic reference designation.

8-11. Figure 8-1 is used as an example. The basic reference designation (R1) appears four times, however each R1 is identified by a designation formed by combining component, assembly and sub-assembly designators. Consider the R1 on sub-assembly A1. The complete designation of that resistor is A2A1R1. Now, R1 connected between assembly A1 and the complete instrument has only the designation R1 because it is not mounted on an assembly. This system applies to all classes of components, C, CR, Q, etc.

8-12. Assemblies are numbered from 1, consecutively. If an assembly number is assigned and later deleted, this number is not reused.

8-13. TROUBLESHOOTING.

8-14. The first and most important requirement for successful troubleshooting is a thorough understanding of how the instrument is designed to operate. Section III (Operation) and Section IV (Theory of Operation) of this manual are intended to provide the operator with the necessary understanding to troubleshoot this instrument. Many times suspected malfunctions are caused

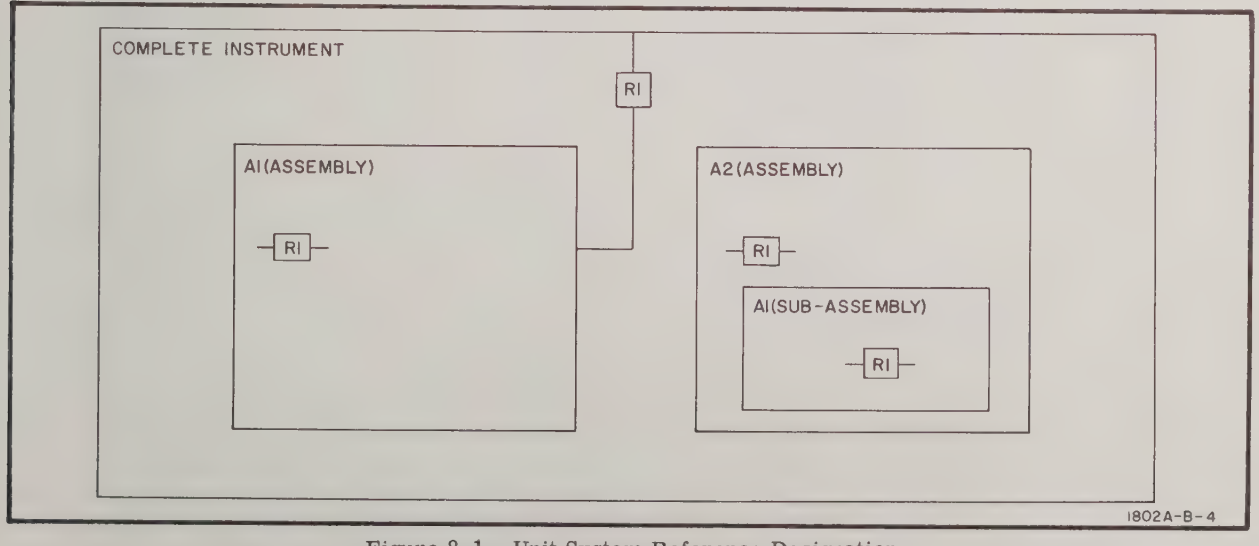


Figure 8-1. Unit System Reference Designation.

by improper control settings or system hook-up. Therefore, it is recommended that the operator become as familiar as possible with the operation of the Model 1802A before troubleshooting.

8-15. To locate a trouble, start with a thorough visual inspection of front panel control settings and hook-up. Look for burned or loose components, mis-wiring or any condition which suggests a trouble. Square pin wiring is shown on each component pictorial. Refer to these callouts, after a board has been replaced, to assure proper connections. Correct any faults located and instrument performance before continuing to troubleshoot.

Note

Test point jacks shown on schematics are used in various checks and adjustments and do not necessarily correspond to waveform test points.

8-16. The first electrical check should be to insure that proper voltages are coming out the printed circuit boards. Check the Low Voltage Power Supply (LVPS) to insure all voltages are correct. Use the overall block diagram (Section IV), the schematic diagrams, and the waveform photos adjacent to each schematic. This procedure will isolate the trouble to a particular circuit. When trouble appears probably in a circuit, check the dc voltages given on the schematics.

8-17. WAVEFORMS.

8-18. Typical waveform measurement points (refer to Table 8-1) are located at strategic points along the main signal path. The numbers inside the symbol refer to a corresponding waveform photo. Conditions for making the waveform measurements are given in Table 8-2.

8-19. DC VOLTAGES.

8-20. DC voltage levels are shown on schematic diagram for all active components (transistors, mainly). Conditions for making dc voltage measurements are given in Table 8-2. In locating points on printed circuit boards, note a small dot on the board identifying the emitter lead of transistors, the source lead of a field effect transistor (FET), the cathode lead of diodes, and the positive side of electrolytic capacitors. On dual transistors only, the tab denotes the collector leads.

8-21. REPAIR AND REPLACEMENT.

8-22. The following paragraphs provide procedures for replacing components and special considerations for removing components from printed circuit boards. Section VI provides a detailed parts list to permit ordering of replacement parts. If satisfactory repair or replacement cannot be accomplished, notify the nearest HP Sales/Service Office (addresses at rear of this manual) immediately. If shipment for repair is recommended, see Section II of this manual for repackaging and shipping information.

8-23. SERVICING PRINTED CIRCUIT BOARDS.

8-24. Printed circuit boards in this instrument have components mounted on one side, conductive surfaces on both sides, and plated through component mounting holes. Hewlett-Packard Service Note M-20E contains useful information on servicing and repair of printed circuit boards. Some important considerations are as follows:

a. Use a 37 to 47.5 watt chisel tip soldering iron with a tip diameter of 1/16 to 1/8 inch, and a small diameter rosin core solder.

b. Components may be removed by placing the soldering iron to component leads on either side of the board. If heat is applied to the component side of the board, greater care is required so as not to damage components. Extreme care is required to avoid damage to semiconductor devices. Damage may be minimized by using long nose pliers. By gripping component lead between soldering iron and component, damage to component is greatly reduced.

c. If a component is obviously damaged or faulty, clip the leads close to the component, then unsolder the leads from the board.

d. Large components, such as potentiometers, may be removed by rotating the iron from one lead to another while gently applying pressure to lift the component from the board.

e. Excessive heat or force will destroy the laminate bond between the metal plated surface and the board. If this should occur, the lifted conductor may be cemented down with a small amount of quick drying acetate base cement having good insulating properties. If this repair cannot be accomplished, a section of good conducting wire may be soldered along the damaged area.

f. Before replacing a component, heat the remaining solder in the component hole and clean it out with a toothpick or similar object. Sharp pointed metallic tools are not recommended because they may damage the plated through surface of the hole.

g. Tin and shape leads of replacement component to fit existing holes.

h. Install components in the same position as the original component (refer to Paragraph 8-20).

i. When removing or replacing square pin connections be sure to pull straight up for removal and replacement. These connections can loosen and cause poor contact.

Table 8-1. Schematic Diagram Notes

Refer to MIL-STD-15-1A for schematic symbols not listed in this table.

= Etched circuit board

= Front panel marking

= Rear panel marking

= Front panel control

= Screwdriver adjustment

P/O = Part of

CW = Clockwise end of variable resistor

NC = No connection

= Waveform test point (with number)

= Common electrical point (with letter) not necessarily ground

= Single pin connector

= Pin of a plug-in board (with letter or number)

= Primary signal flow

= Secondary signal flow

* = Optimum value selected at factory, average value shown; part may have been omitted.

= Field effect transistor (N-channel)

Breakdown diode

Tunnel diode

= Step recovery diode

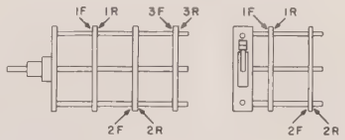
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

Unless otherwise indicated:
resistance in ohms
capacitance in picofarads
inductance in microhenries

Wire colors are given by numbers in parentheses using the resistor color code [(925) is wht-red-grn].

0 - Black
1 - Brown
2 - Red
3 - Orange
4 - Yellow
5 - Green
6 - Blue
7 - Violet
8 - Gray
9 - White

Switch wafers are identified as follows:



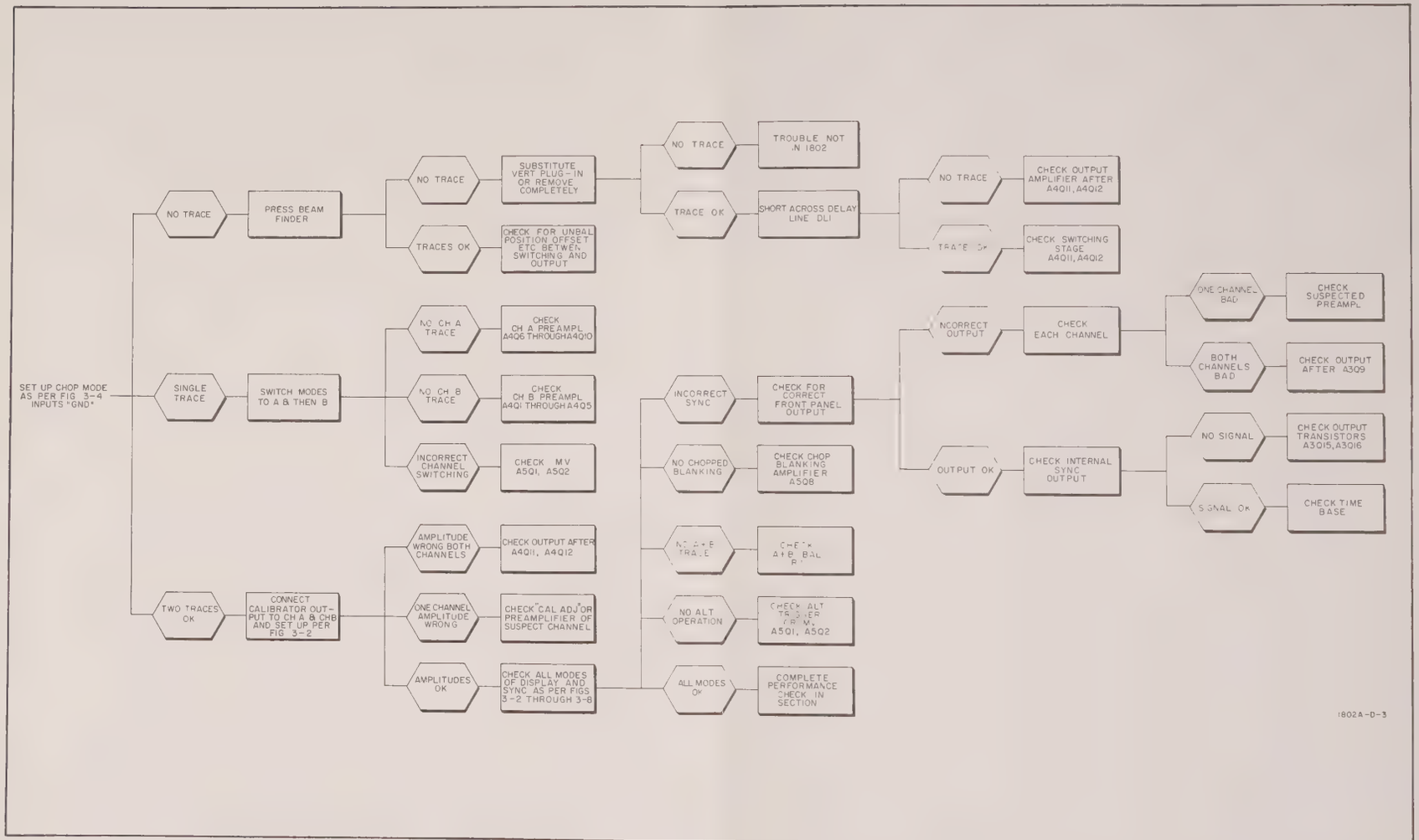

SET UP CHOP MODE AS PER FIG 3-4 INPUTS "GND"
NO TRACE
PRESS BEAM FINDER
NO TRACE
SUBSTITUTE VERT PLUG-IN OR REMOVE COMPLETELY
TRACES OK
CHECK FOR UNBAL POSITION OFFSET ETC BETWEEN SWITCHING AND OUTPUT
NO TRACE
TROUBLE NOT IN 1802
TRACE OK
SHORT ACROSS DELAY LINE DL1
NO TRACE
CHECK OUTPUT AMPLIFIER AFTER A4Q11, A4Q12
TRACE OK
CHECK SWITCHING STAGE A4Q11, A4Q12
SINGLE TRACE
SWITCH MODES TO A & THEN B
NO CH A TRACE
CHECK CH A PREAMPL A4Q6 THROUGH A4Q10
NO CH B TRACE
CHECK CH B PREAMPL A4Q1 THROUGH A4Q5
INCORRECT CHANNEL SWITCHING
CHECK M V A5Q1, A5Q2
INCORRECT SYNC
CHECK FOR CORRECT FRONT PANEL OUTPUT
NO CHOPPED BLANKING
CHECK CHOP BLANKING AMPLIFIER A5Q8
NO ALT TRACE
CHECK A+B BAL R
NO ALT OPERATION
CHECK ALT TRIGGER FF M A5Q1, A5Q2
ALL MODES OK
COMPLETE PERFORMANCE CHECK IN SECTION
INCORRECT OUTPUT
CHECK EACH CHANNEL
ONE CHANNEL BAD
CHECK SUSPECTED PREAMPL
BOTH CHANNELS BAD
CHECK OUTPUT AFTER A3Q9
OUTPUT OK
CHECK INTERNAL SYNC OUTPUT
NO SIGNAL
CHECK OUTPUT TRANSISTORS A3Q15, A3Q16
SIGNAL OK
CHECK TIME BASE
TWO TRACES OK
CONNECT CALIBRATOR OUTPUT TO CH A & CH B AND SET UP PER FIG 3-2
AMPLITUDE WRONG BOTH CHANNELS
CHECK OUTPUT AFTER A4Q11, A4Q12
ONE CHANNEL AMPLITUDE WRONG
CHECK CAL ADJ OR PREAMPLIFIER OF SUSPECT CHANNEL
AMPLITUDES OK
CHECK ALL MODES OF DISPLAY AND SYNC AS PER FIGS 3-2 THROUGH 3-8
1802A-D-3

Figure 8-2. Troubleshooting Tree

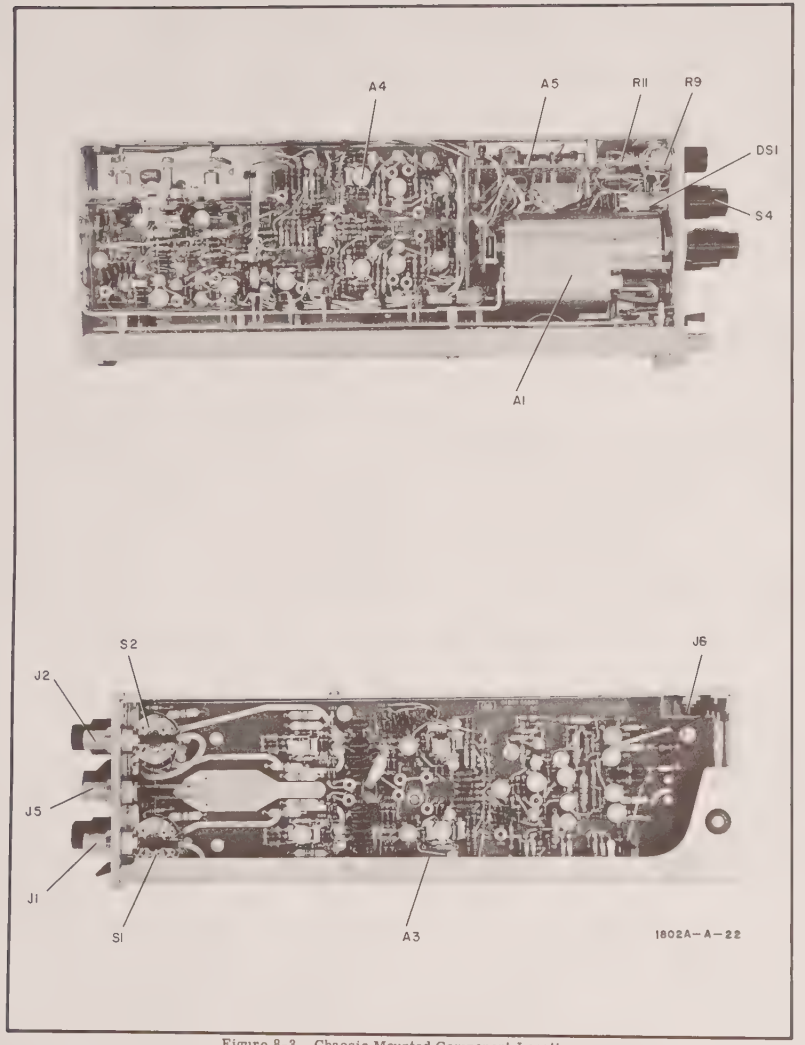


Figure 8-3. Chassis Mounted Component Locations.

Table 8-2. Waveform and DC Voltage Measurement Conditions

WAVEFORMS

The test point waveforms, as given in figures preceeding the schematic diagrams, were taken under the following conditions:

MODEL 1802A

POSITION (both channels)	centered
DISPLAY	A + B
INPUTS	UP
SYNC SOURCE	NORM
Vernier (CAL)	fully cw

Connect the 10-volt pk-pk, 1 kHz square wave from the Model 180-Series Oscilloscope CALIBRATOR jack to INPUT of channel under test.

Any exceptions to these conditions are noted adjacent to the applicable waveform photo.

DC VOLTAGES

The DC voltage readings, as given on the schematic diagrams, were taken under the conditions given below. Exceptions are given preceeding the schematic diagram.

All voltages are measured with referenceto chassis ground.

Voltage readings are considered normal if within 10% of voltage given on the schematic.

Control Settings:

POSITION	centered
DISPLAY	A
INPUTS	OFF
SYNC SOURCE	NORM

Figure 8-4. Attenuator Waveform

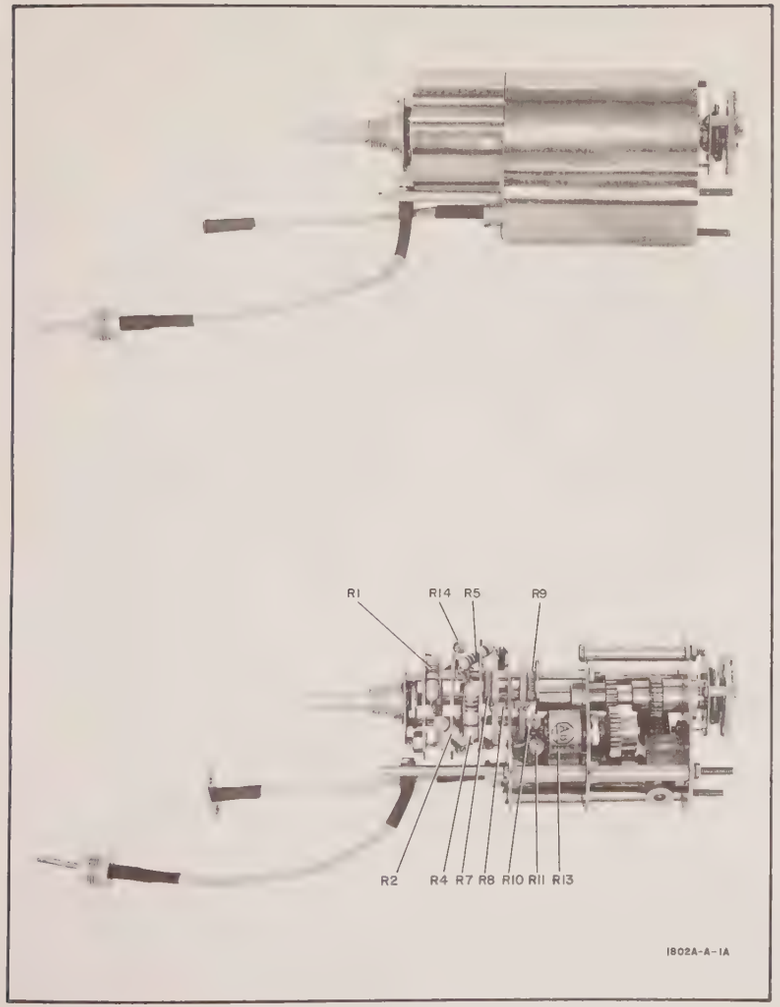


Figure 8-5. Attenuator Component Location

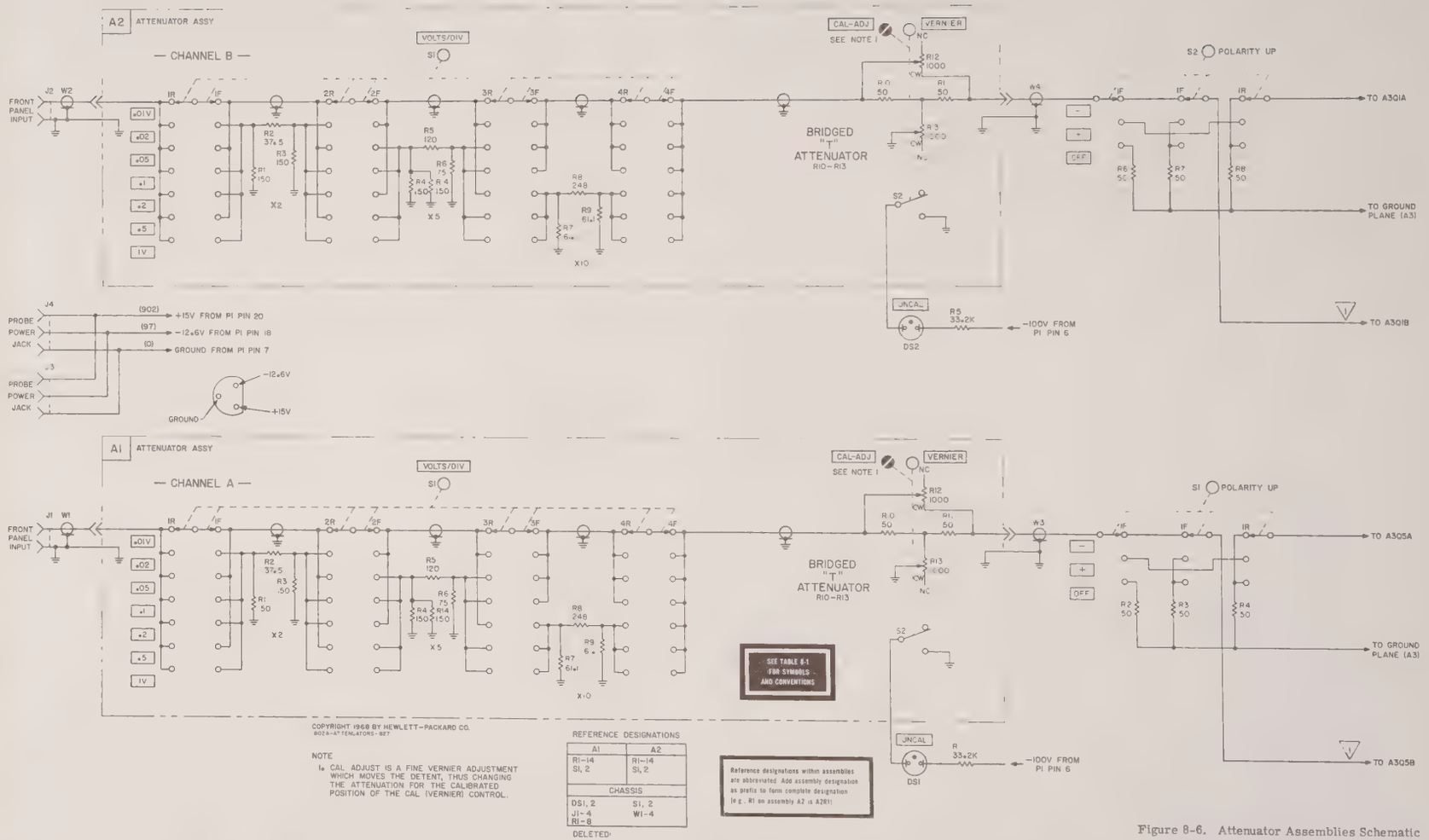
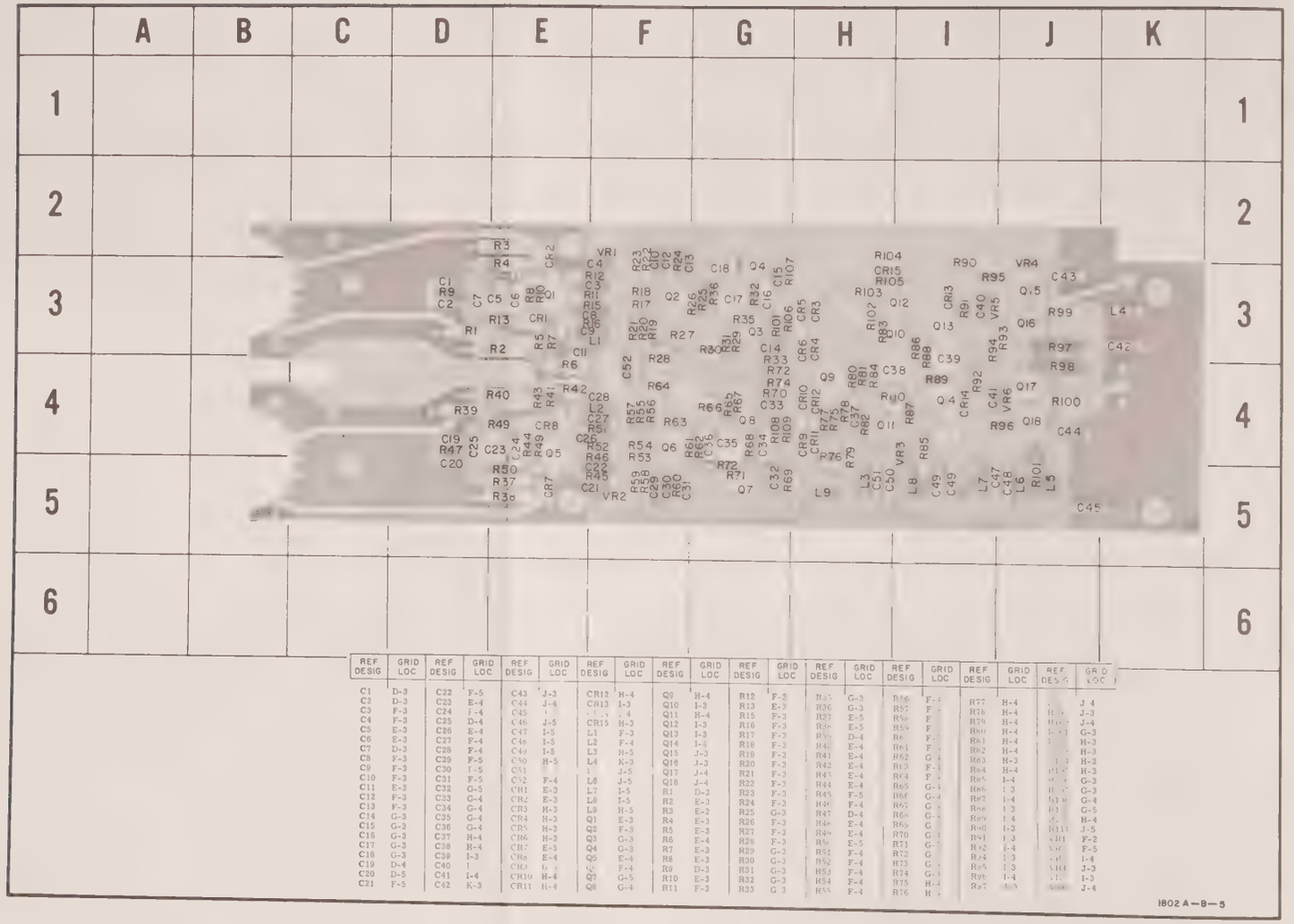


Figure 8-6. Attenuator Assemblies Schematic Diagram



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C1	D-3	C22	F-5	C43	J-3	CR12	H-4	Q9	H-4	R12	F-3	R25	G-3	R56	F-4	R77	H-4	[illegible]	J-4
C2	D-3	C23	E-4	C44	J-4	CR13	I-3	Q10	I-3	R13	E-3	R26	G-3	R57	F-4	R78	H-4	[illegible]	J-3
C3	F-3	C24	F-4	C45	[illegible]	[illegible]	[illegible]	Q11	H-4	R15	F-3	R27	E-5	R58	F-4	R79	H-4	[illegible]	J-4
C4	F-3	C25	D-4	C46	J-5	CR15	H-3	Q12	I-3	R16	F-3	R28	E-5	R59	F-4	R80	H-4	[illegible]	G-3
C5	E-3	C26	E-4	C47	I-5	L1	F-3	Q13	I-3	R17	F-3	R30	D-4	R60	F-4	R81	H-4	[illegible]	H-3
C6	E-3	C27	F-4	C48	I-5	L2	F-4	Q14	I-4	R18	F-3	R40	E-4	R61	F-4	R82	H-4	[illegible]	H-3
C7	D-3	C28	F-4	C49	I-5	L3	H-5	Q15	J-3	R19	F-3	R41	E-4	R62	G-4	R83	H-3	[illegible]	H-2
C8	F-3	C29	F-5	C50	H-5	L4	K-3	Q16	J-3	R20	F-3	R42	E-4	R63	H-3	[illegible]	I-3	[illegible]	H-2
C9	F-3	C30	I-5	C51	[illegible]	[illegible]	J-5	Q17	J-4	R21	F-3	R43	E-4	R64	H-4	[illegible]	[illegible]	[illegible]	H-3
C10	F-3	C31	F-5	C52	F-4	L6	J-5	Q18	J-4	R22	F-3	R44	E-4	R65	G-4	R85	I-4	[illegible]	G-3
C11	E-3	C32	G-5	CR1	E-3	L7	I-5	R1	D-3	R23	F-3	R45	F-5	R66	I-3	R86	[illegible]	[illegible]	G-3
C12	F-3	C33	G-4	CR2	E-3	L8	I-5	R2	E-3	R24	F-3	R46	F-4	R67	G-4	R87	I-4	[illegible]	G-4
C13	F-3	C34	G-4	CR3	H-3	L9	H-5	R3	E-2	R25	G-3	R47	D-4	R68	G-4	R88	I-3	[illegible]	G-5
C14	G-3	C35	G-4	CR4	H-3	Q1	E-3	R4	E-3	R26	F-3	R48	E-4	R69	G-4	R89	I-4	[illegible]	H-4
C15	G-3	C36	G-4	CR5	H-3	Q2	F-3	R5	E-3	R27	F-3	R49	E-4	R70	G-4	R90	I-3	[illegible]	J-5
C16	G-3	C37	H-4	CR6	H-3	Q3	G-3	R6	E-4	R28	F-3	R50	E-5	R71	G-4	R91	I-3	[illegible]	F-2
C17	G-3	C38	H-4	CR7	E-5	Q4	G-3	R7	E-3	R29	G-3	R51	F-4	R72	G-4	R92	I-4	[illegible]	F-5
C18	G-3	C39	I-3	CR8	E-4	Q5	E-4	R8	E-3	R30	G-3	R52	F-4	R73	G-4	R93	I-3	[illegible]	I-4
C19	D-4	C40	I-4	CR9	[illegible]	Q6	F-4	R9	D-3	R31	G-3	R53	F-4	R74	G-4	R95	I-3	[illegible]	J-3
C20	D-5	C41	I-4	CR10	H-4	Q7	G-5	R10	E-3	R32	G-3	R54	F-4	R75	H-4	R96	I-4	[illegible]	I-3
C21	F-5	C42	K-3	CR11	H-4	Q8	G-4	R11	F-3	R33	G-3	R55	F-4	R76	H-4	R97	I-3	[illegible]	J-4

Figure 8-7. Component Identification Assembly A3

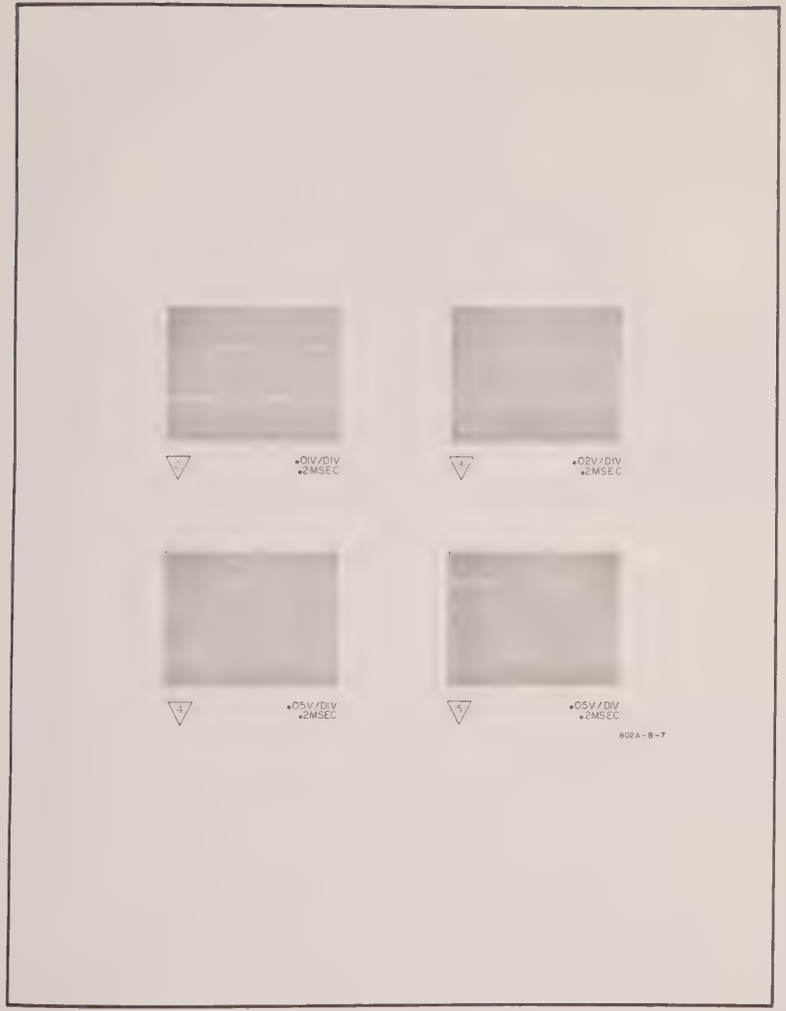


Figure 8-8. Sync Amplifier Waveforms

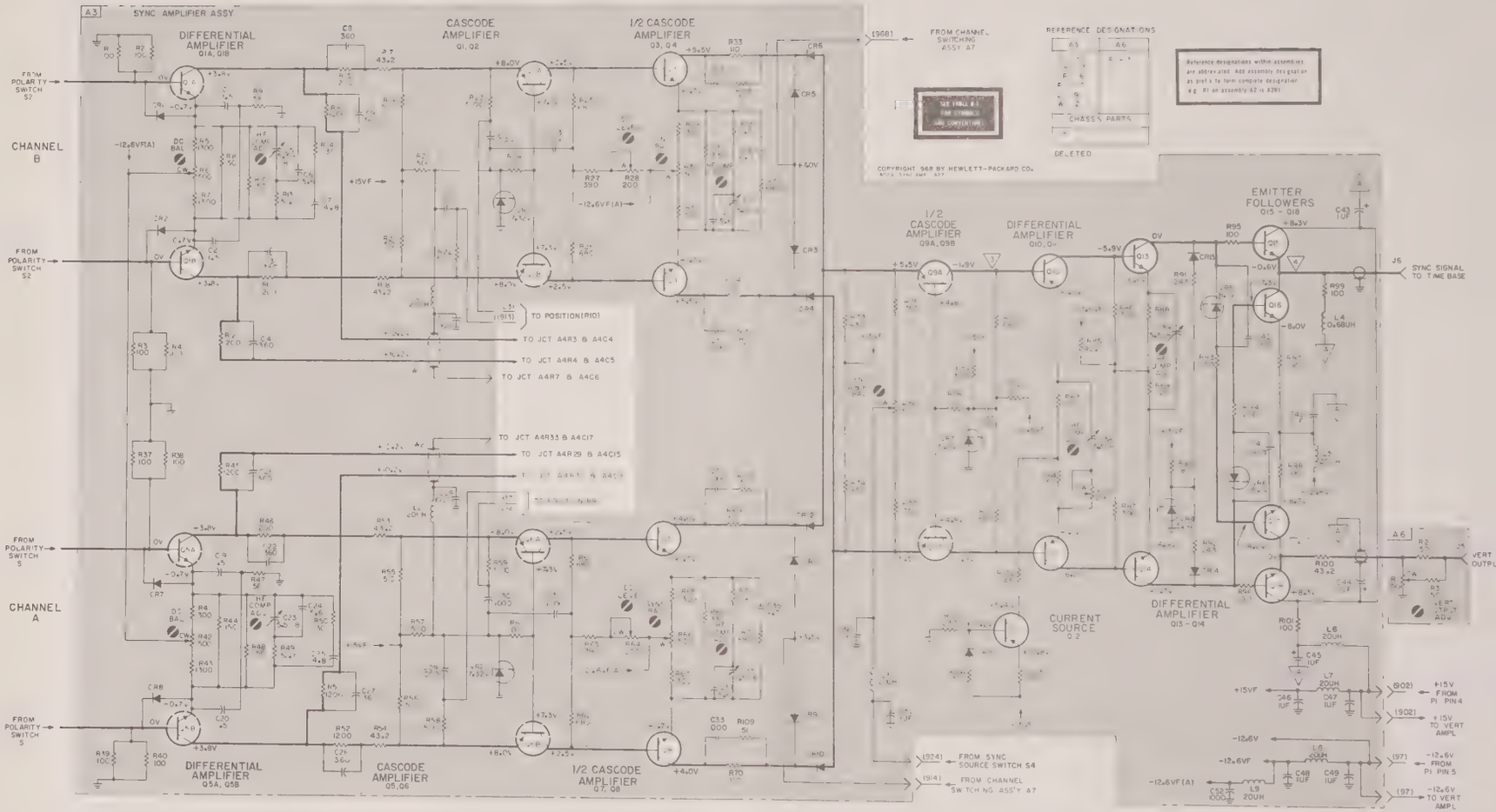
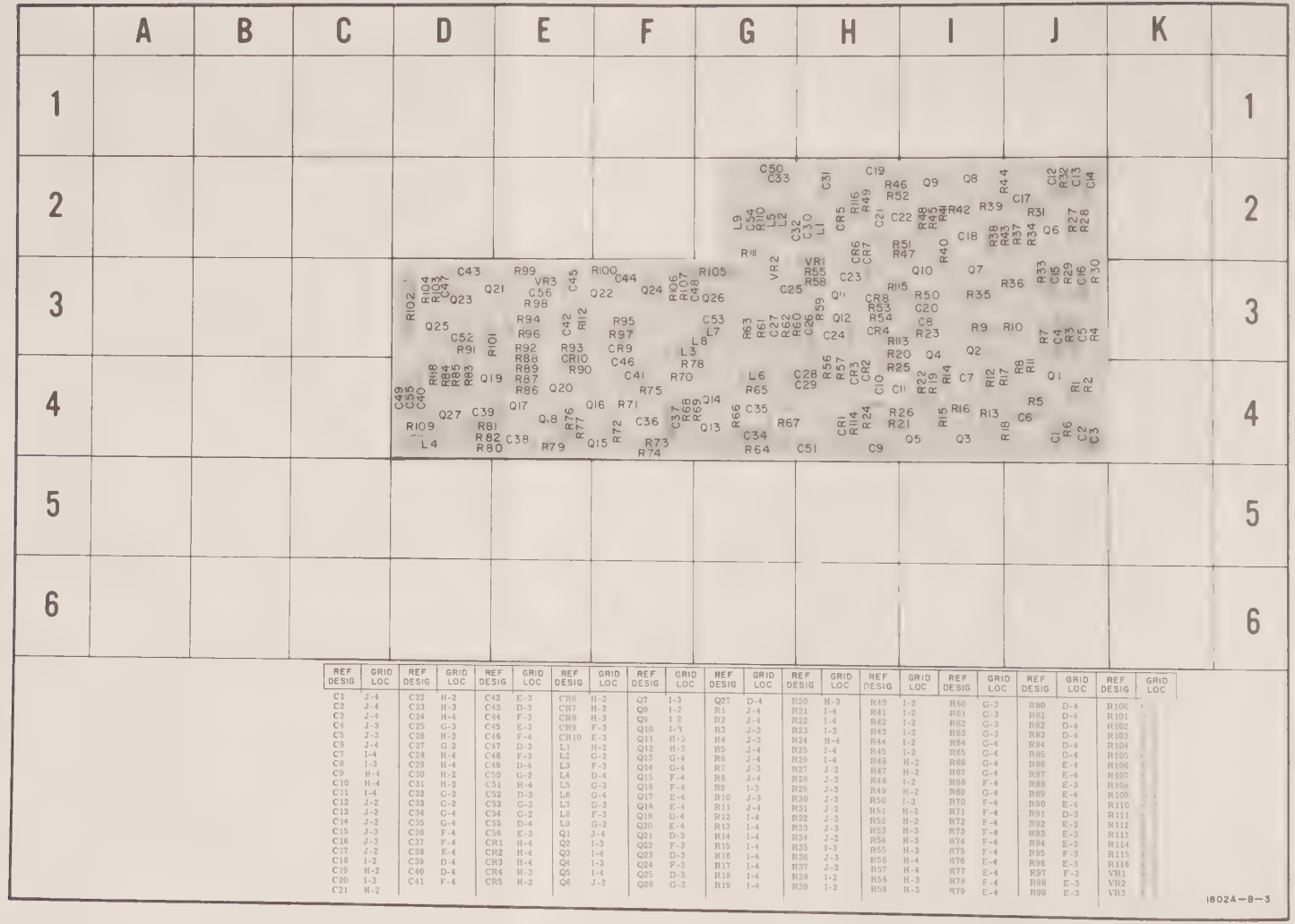


Figure 8-9. Sync Amplifier Schematic Diagram



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C1	J-4	C22	H-2	C42	E-3	CR6	H-2	Q7	I-3	Q27	D-4	R20	H-3	R40	I-2	R60	G-3	R80	D-4	R100	
C2	J-4	C23	H-3	C43	D-3	CR7	H-2	Q8	I-2	R1	J-4	R21	I-4	R41	I-2	R61	G-3	R81	D-4	R101	
C3	J-4	C24	H-4	C44	F-3	CR8	H-3	Q9	I-2	R2	J-4	R22	I-4	R42	I-2	R62	G-3	R82	D-4	R102	
C4	J-3	C25	G-3	C45	E-3	CR9	F-3	Q10	I-3	R3	J-3	R23	I-3	R43	I-2	R63	G-3	R83	D-4	R103	
C5	J-3	C26	H-3	C46	F-4	CR10	E-3	Q11	H-3	R4	J-3	R24	H-4	R44	I-2	R64	G-4	R84	D-4	R104	
C6	J-4	C27	G-3	C47	D-3	L1	H-2	Q12	H-3	R5	J-4	R25	I-4	R45	I-2	R65	G-4	R85	D-4	R105	
C7	I-4	C28	H-4	C48	F-3	L2	G-2	Q13	G-4	R6	J-4	R26	I-4	R46	H-2	R66	G-4	R86	E-4	R106	
C8	I-3	C29	H-4	C49	D-4	L3	F-3	Q14	G-4	R7	J-3	R27	J-2	R47	H-2	R67	G-4	R87	E-4	R107	
C9	H-4	C30	H-2	C50	G-2	L4	D-4	Q15	F-4	R8	J-4	R28	J-2	R48	I-2	R68	F-4	R88	E-3	R108	
C10	H-4	C31	H-2	C51	H-4	L5	G-2	Q16	F-4	R9	I-3	R29	J-3	R49	H-2	R69	G-4	R89	E-4	R109	
C11	I-4	C32	G-2	C52	D-3	L6	G-4	Q17	E-4	R10	J-3	R30	J-3	R50	I-3	R70	F-4	R90	E-4	R110	
C12	J-2	C33	G-2	C53	G-3	L7	G-3	Q18	E-4	R11	J-4	R31	J-2	R51	H-2	R71	F-4	R91	D-3	R111	
C13	J-2	C34	G-4	C54	G-2	L8	F-3	Q19	D-4	R12	I-4	R32	J-2	R52	H-2	R72	F-4	R92	E-3	R112	
C14	J-2	C35	G-4	C55	D-4	L9	G-2	Q20	E-4	R13	I-4	R33	J-3	R53	H-3	R73	F-4	R93	E-3	R113	
C15	J-3	C36	F-4	C56	E-3	Q1	J-4	Q21	D-3	R14	I-4	R34	J-2	R54	H-3	R74	F-4	R94	E-3	R114	
C16	J-3	C37	F-4	CR1	H-4	Q2	I-3	Q22	F-3	R15	I-4	R35	I-3	R55	H-3	R75	F-4	R95	F-3	R115	
C17	J-2	C38	E-4	CR2	H-4	Q3	I-4	Q23	D-3	R16	I-4	R36	J-3	R56	H-4	R76	E-4	R96	E-3	R116	
C18	I-2	C39	D-4	CR3	H-4	Q4	I-3	Q24	F-3	R17	I-4	R37	J-2	R57	H-4	R77	E-4	R97	F-3	VR1	
C19	H-2	C40	D-4	CR4	H-3	Q5	I-4	Q25	D-3	R18	I-4	R38	I-2	R58	H-3	R78	F-4	R98	E-3	VR2	
C20	I-3	C41	F-4	CR5	H-2	Q6	J-2	Q26	G-3	R19	I-4	R39	I-2	R59	H-3	R79	E-4	R99	E-3	VR3	
C21	H-2																				

Figure 8-10. Component Identification Assembly A4

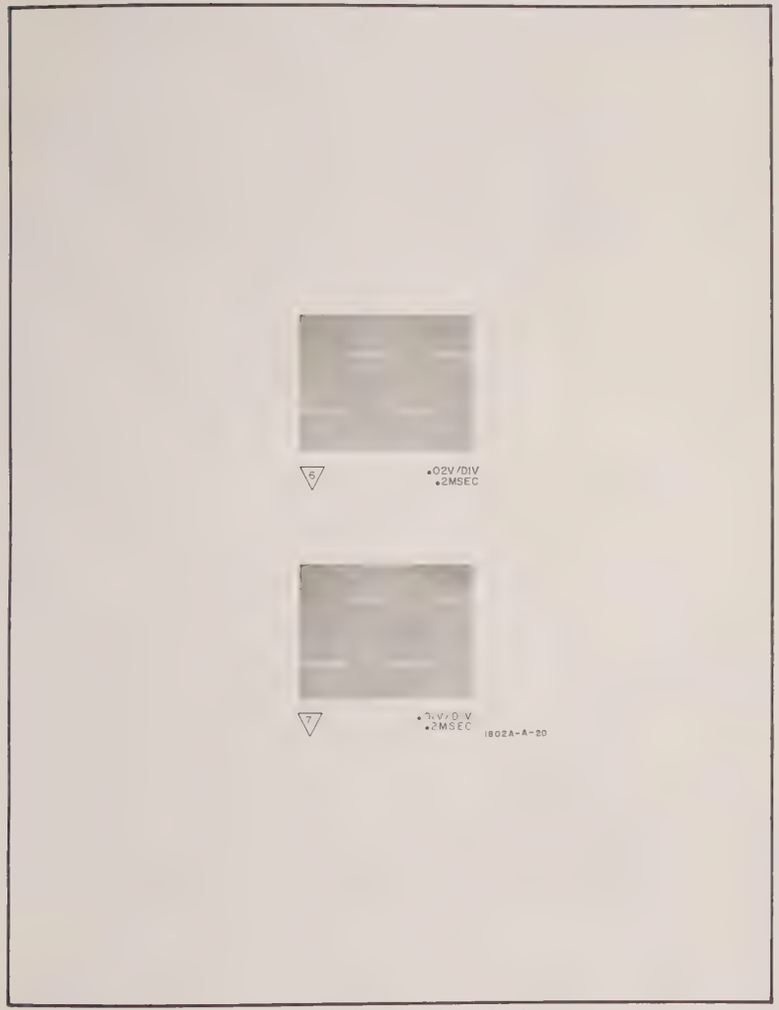


Figure 8-11. Vertical Amplifier Waveforms

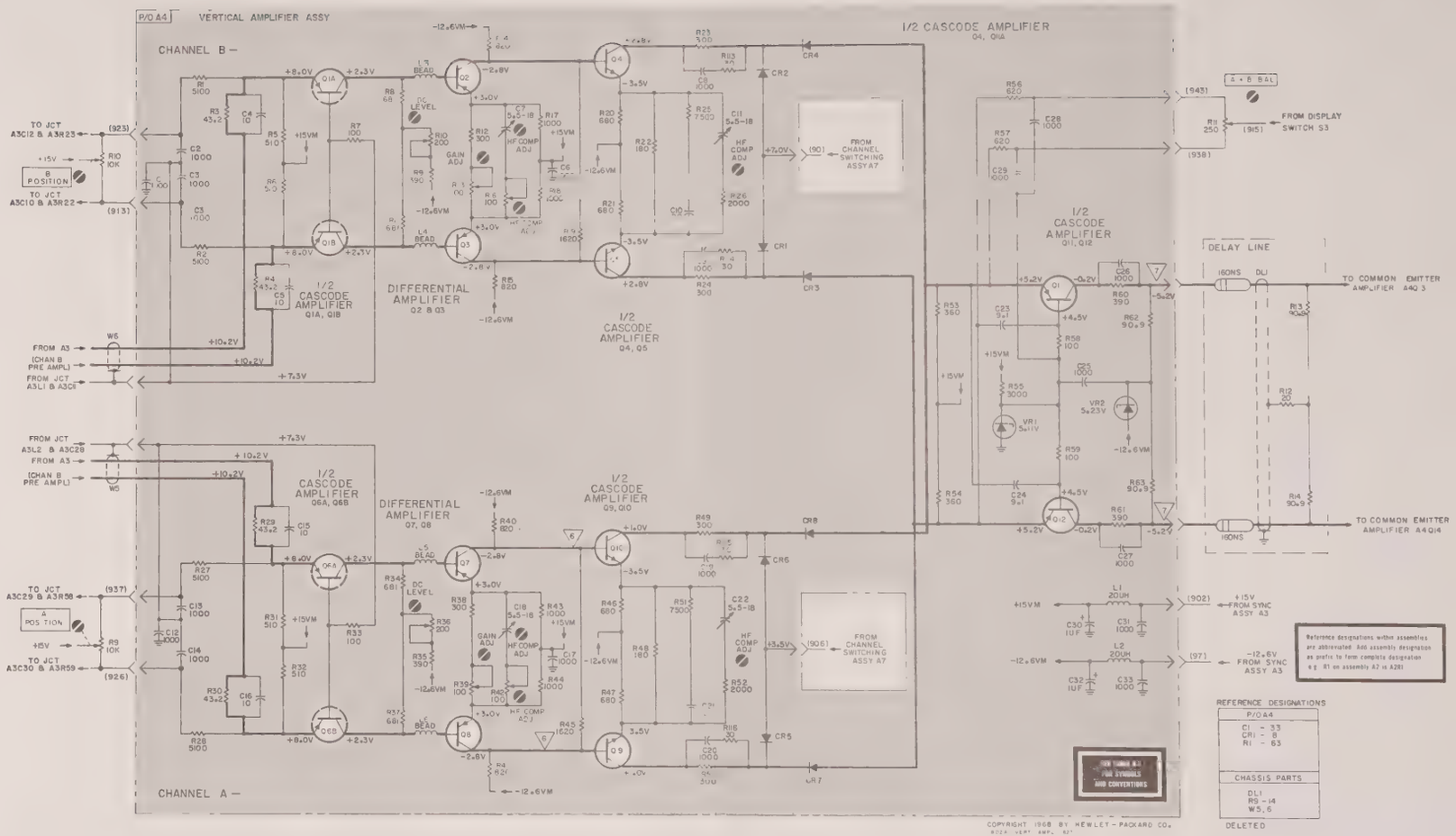


Figure 8-12. Vertical Amplifier Schematic Diagram

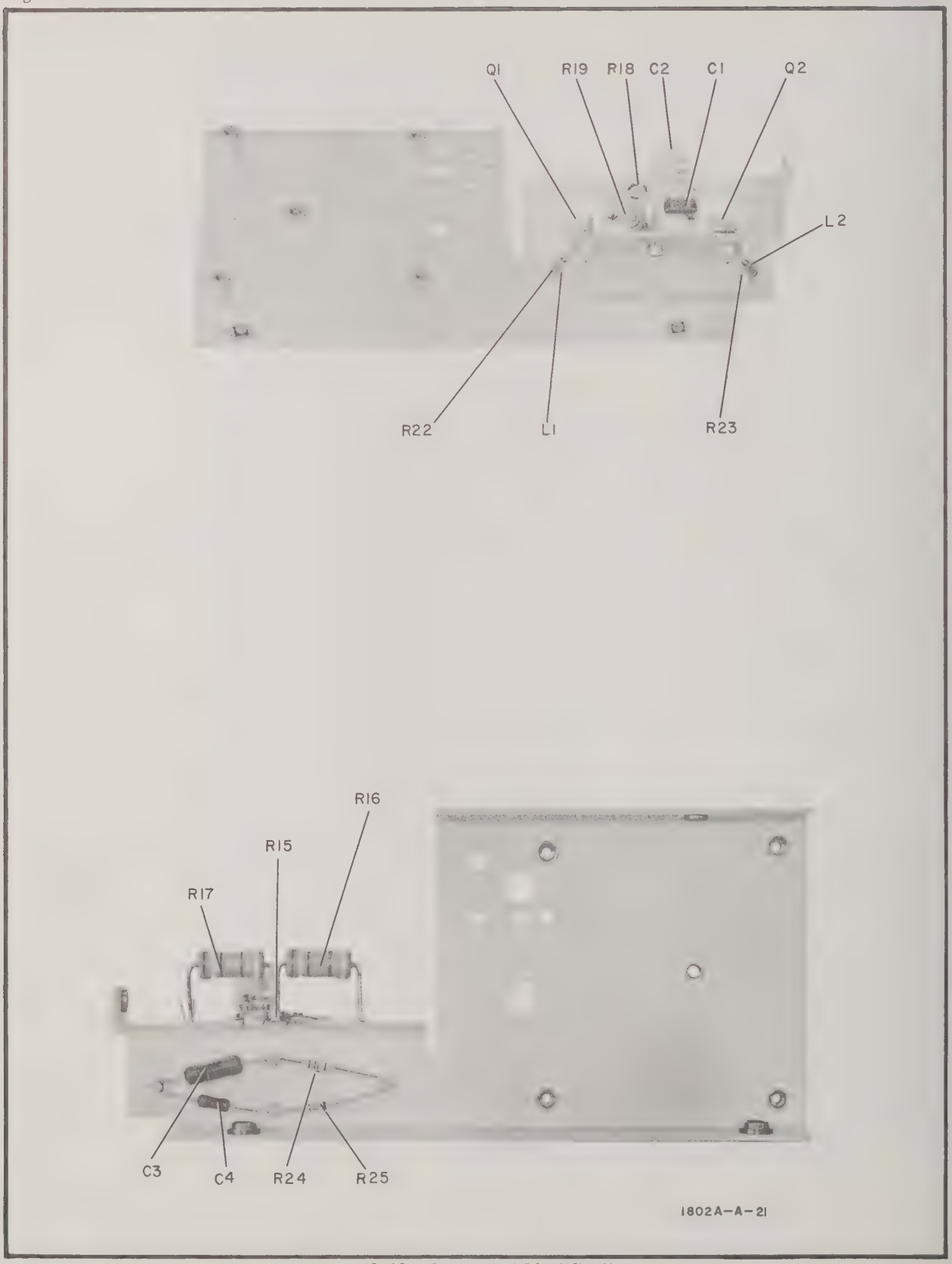


Figure 8-13. Component Identification

Figure 8-14. Vertical Output Amplifier Waveforms

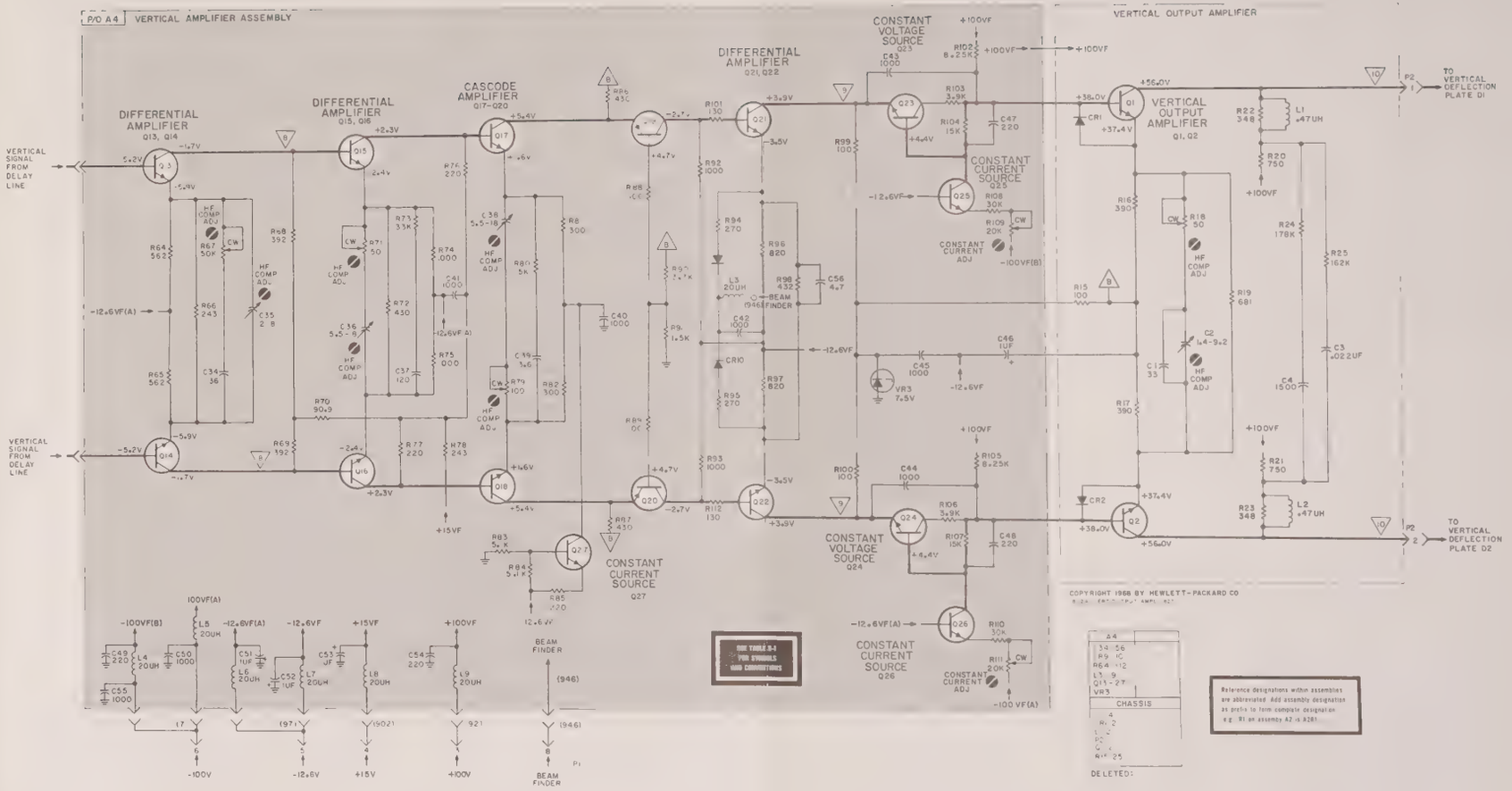
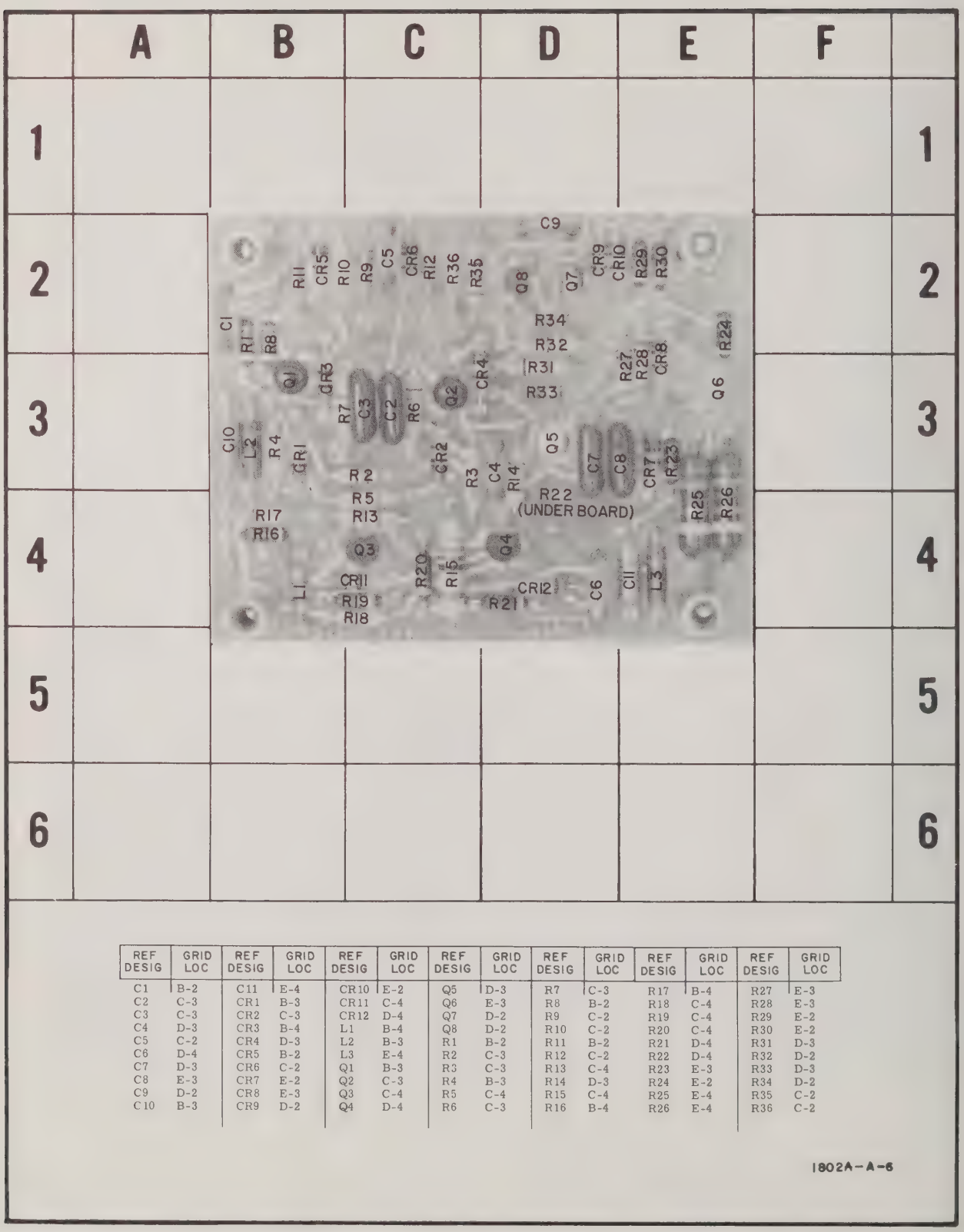


Figure 8-15. Vertical Output Amplifier Schematic Diagram 8-11



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	B-2	C11	E-4	CR10	E-2	Q5	D-3	R7	C-3	R17	B-4	R27	E-3
C2	C-3	CR1	B-3	CR11	C-4	Q6	E-3	R8	B-2	R18	C-4	R28	E-3
C3	C-3	CR2	C-3	CR12	D-4	Q7	D-2	R9	C-2	R19	C-4	R29	E-2
C4	D-3	CR3	B-4	L1	B-4	Q8	D-2	R10	C-2	R20	C-4	R30	E-2
C5	C-2	CR4	D-3	L2	B-3	R1	B-2	R11	B-2	R21	D-4	R31	D-3
C6	D-4	CR5	B-2	L3	E-4	R2	C-3	R12	C-2	R22	D-4	R32	D-2
C7	D-3	CR6	C-2	Q1	B-3	R3	C-3	R13	C-4	R23	E-3	R33	D-3
C8	E-3	CR7	E-2	Q2	C-3	R4	B-3	R14	D-3	R24	E-2	R34	D-2
C9	D-2	CR8	E-3	Q3	C-4	R5	C-4	R15	C-4	R25	E-4	R35	C-2
C10	B-3	CR9	D-2	Q4	D-4	R6	C-3	R16	B-4	R26	E-4	R36	C-2

1802A-A-6

Figure 8-16. Component Location Assembly A5

Figure 8-17. Channel Switching Waveforms

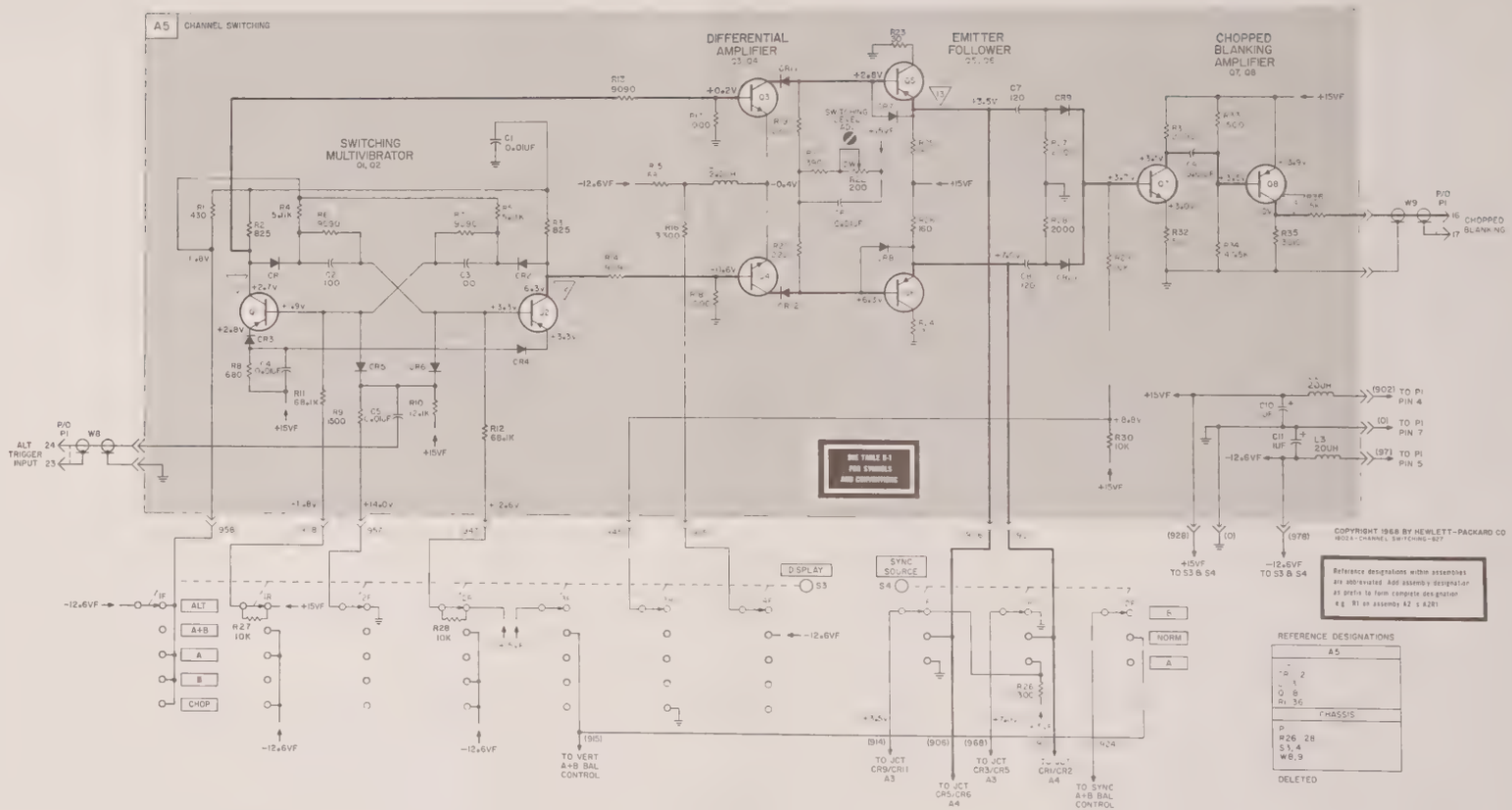


Figure 8-18. Channel Switching Schematic Diagram
8-13

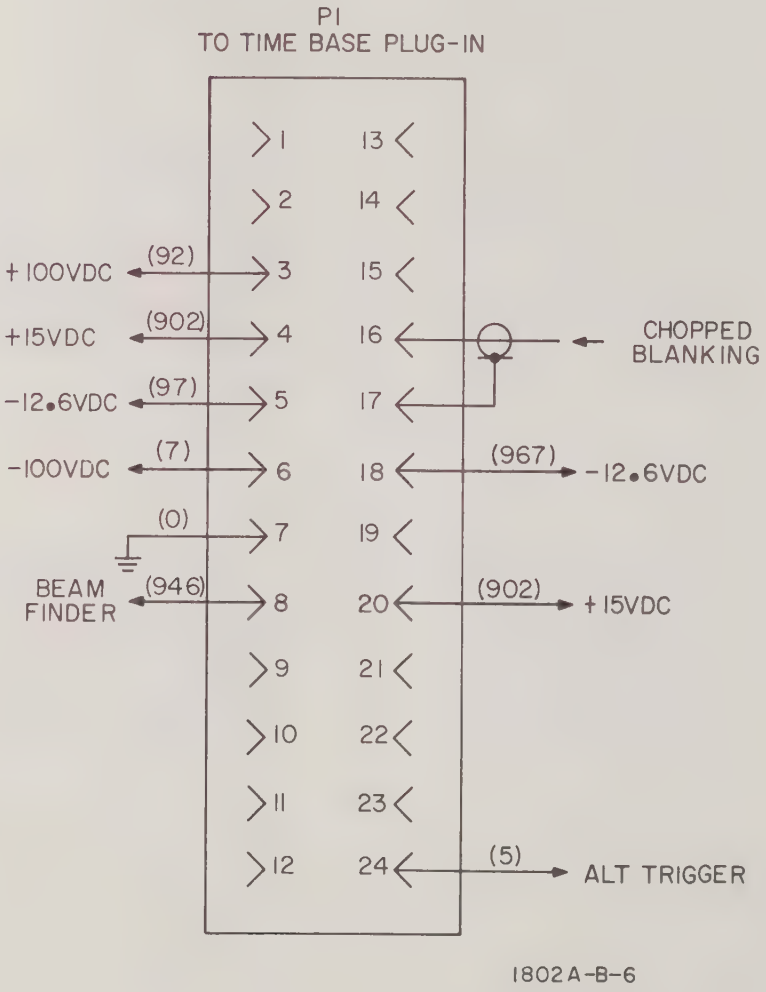


Figure 8-19. Plug Connections

HEWLETT • PACKARD SALES AND SERVICE

UNITED STATES

ALABAMA
P.O. Box 4207
2003 Byrd Spring Road S.W.
Huntsville 35802
Tel: (205) 881-4591
TWX: 810-726-2204

ARIZONA
3009 North Scottsdale Road
Scottsdale 85251
Tel: (602) 945-7601
TWX: 910-950-1282

232 South Tucson Boulevard
Tucson 85716
Tel: (602) 623-2564
TWX: 910-952-1162

CALIFORNIA
3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2591 Carlsbad Avenue
Sacramento 95821
Tel: (916) 482-1463
TWX: 910-367-2092

1055 Shafter Street
San Diego 92106
Tel: (714) 223-8103
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
508 Tolland Street
East Hartford 06108
Tel: (203) 289-9394
TWX: 710-425-3416

111 East Avenue
Norwalk 06851
Tel: (203) 853-1251
TWX: 710-468-3750

DELAWARE
3941 Kennett Pike
Wilmington 19807
Tel: (302) 655-6161
TWX: 510-666-2214

FLORIDA
P.O. Box 545
Suite 106
9999 N.E. 2nd Avenue
Miami Shores 33153
Tel: (305) 758-3626
TWX: 810-848-7262

P.O. Box 20007
Herndon Station 32814
621 Commonwealth Avenue
Orlando
Tel: (305) 841-3970
TWX: 810-850-0113

P.O. Box 8128
Madeira Beach 33708
410 150th Avenue
St. Petersburg
Tel: (813) 391-0211
TWX: 810-863-0366

GEORGIA
P.O. Box 28234
450 Interstate North
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
4002 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

LOUISIANA
P.O. Box 856
1942 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-0850

P.O. Box 1648
2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Ave.
Lexington 02173
Tel: (301) 948-6370
TWX: 710-332-0382

MICHIGAN
24315 Northwestern Highway
Southfield 48075
Tel: (313) 353-9100
TWX: 810-232-1532

MINNESOTA
2459 University Avenue
St. Paul 55114
Tel: (612) 645-9461
TWX: 910-563-3734

MISSOURI
9208 Wyoming Place
Kansas City 64114
Tel: (816) 333-2445
TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
Tel: (314) 644-0220
TWX: 910-760-1670

NEW JERSEY
W. 120 Cetury Road
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

1050B N. Kings Highway
Cherry Hill 08034
Tel: (609) 667-4000
TWX: 710-892-4945

NEW MEXICO
P.O. Box 8366
Station C
6501 Lomas Boulevard N.E.
Albuquerque 87108
Tel: (505) 255-5586
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
1702 Central Avenue
Albany 12205
Tel: (518) 869-8462
TWX: 710-441-8270

1219 Campville Road
Endicott 13764
Tel: (607) 754-0050
TWX: 510-252-0890

82 Washington Street
Poughkeepsie 12601
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